THE
JOURNAL OF
COMPARATIVE PATHOLOGY
AND
THERAPEUTICS.

Vol. L.—No. 4. DECEMBER 31st, 1937. PRICE 7s. 6d.

JUBILEE NUMBER

A *Festschrift* to Sir John M'Fadyean

THE RECOMPENSE.

[Extract from the speech* in reply to the toast of " Our Guest," at the Complimentary Banquet given to Sir John M'Fadyean on January 4th, 1906, in honour of the knighthood that had just been conferred upon him.]

" . . . I can certainly say that through the whole of my professional career, I have always felt profoundly thankful for the good fortune which placed me in a profession which is perhaps the one for which I had the greatest natural aptitude and which is certainly the one of which the work has been most congenial to me. I cannot claim it as a merit that I have been always anxious to make the most of opportunities to advance the interests of veterinary science and the veterinary profession, because that was my plain duty; and if in following what was the plain line of duty, I have been fortunate enough to earn the good opinion and good wishes of those who ought to know me best, then I certainly have gained the reward which of all others I most coveted. . . ."

Now, after over 30 more years, those invited will proceed in the following pages to address him as spokesmen on behalf of all " who ought to know him best." Some there are who will convey their messages of " good opinion and good wishes." Others in some short reviews or records of original research in a few of the fields his lifework has enriched will show to him, it is hoped, the heed that is now well taken by his followers of the words at the close of his last inaugural address to his students, in 1913: " . . . you should endeavour to add to the sum of existing veterinary knowledge, so that when your labours are finished, your professional brethren may say, ' He left our inheritance richer than he found it.' "

It is devoutly wished that this special Number, while as yet he may long be spared to continue his labours, will leave him in no doubt as to what his brethren will come to say of him.

Vet. Rec.* (1906), January 13th, **18, 487.

An Introductory Message

From VISCOUNT RUNCIMAN OF DOXFORD,
P.C., D.C.L., M.A., LL.D.

Three things were borne into my mind in the course of my time at the Board of Agriculture before the War: First that the difference between live stock that are healthy and live stock that are sick is the difference between farming prosperity and poverty. Second that stockbreeding is of fundamental importance not only to the farmers but also to the Government as trustees for national wealth. Third no service to the farmer can be greater than the elimination of disease.

For these and other sound reasons I always held the same views as my dear friend Sir Stewart Stockman and Sir John MacFadyean, and it is with exceeding pleasure that I see their plans reach fruition.

Runciman of Doxford.

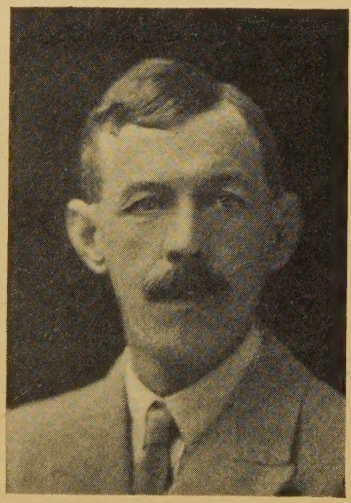
VISCOUNT RUNCIMAN OF DOXFORD.

" The enlightened Minister "* who as Mr. Walter Runciman, M.P., President of the Board (now the Ministry) of Agriculture, with great enterprise applied the resources for the first time made available by the State, through the creation of the Development Fund, an adjunct to Mr. Lloyd George's 1909 Budget, and at that time " something entirely novel in our financial administration,"† to the promotion of veterinary research and education.

" The foundation of the Research Institute must be regarded as one of the most important developments that have taken place at the Ministry of Agriculture since it was constituted, and the credit for that must be divided between Sir Stewart Stockman and the enlightened Minister who adopted his views and found the necessary funds for giving effect to them."*

SIR STEWART STOCKMAN, 1869—1926.

Sir John M'Fadyean's disciple, who succeeded him in the teaching of pathology at the Royal (Dick) Veterinary College, Edinburgh, 1892-1900, and then, after service in India and South Africa, intimately collaborated with him while occupying the appointment of Chief Veterinary Officer of the Board (now the Ministry) of Agriculture from 1905 to 1926. " Without exaggeration it may be said that his life was one of self-sacrificing devotion to the public interests and the advancement of veterinary science."*



* This Journal (1926), **39**, 165.
† *Vet. Rec.* (1935), **47**, 517.

– It gives me very great pleasure to send you Lord Northbrook's photo – I am indeed glad to think that the work he did for the Royal Agricultural Society of England is still remembered & appreciated. I have often heard him speak of Sir John McGadyean – he had a very high opinion of the services he rendered the Society – & would have much liked to have his photo. inserted in the Commemoration Number of the Journal which is to be presented to Sir John –

Yours
Northbrook

ROYAL AGRICULTURAL SOCIETY OF ENGLAND:

A Tribute to Sir John M'Fadyean for his Services.

The late Earl of Northbrook
President, R.A.S.E., 1913.

This photograph has been graciously presented by the Dowager Countess of Northbrook, with the accompanying message.

I THINK I cannot do better than ask you to quote the remarks of the late Earl of Northbrook, on the termination of Sir John M'Fadyean's appointment as Principal of the Royal Veterinary College and as Consulting Veterinary Surgeon to this Society. The occasion in question was at the monthly meeting of the Council of this Society, on April 4th, 1928, and Lord Northbrook then said that he wished to refer briefly to the resignation of Sir John M'Fadyean, which terminated a connection with the Society which had existed for a very large number of years :—

Sir John's first association with the Royal Agricultural Society commenced in the year 1892, when the Society had decided (in 1889) to make an annual grant to the Veterinary College, for the purpose of establishing a Chair of Comparative Pathology and Bacteriology. Sir John became the Professor of Comparative Pathology at the College, and in 1892, he was elected as a member of the Society's Veterinary Committee.

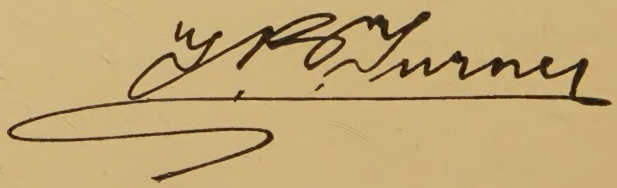
He joined the Society as an ordinary member in 1893, and in 1901, he had conferred upon him the honour of being elected an honorary member of the Society in recognition of his exceptional services to agriculture.

In July, 1904, Sir John was asked to accept the honorary office of Consulting Veterinary Surgeon to the Society. He had held for many years a distinguished position in the veterinary profession. He had done most valuable work in research and in investigation into animal diseases, their cause and treatment. His opinion had always commanded the greatest respect. There were few, if any, men who had done more in recent years for the advancement of veterinary knowledge and the practice of the veterinary art. His sound advice had always been at the disposal of the Veterinary Committee and the Council of the Society, and Sir John had always shown to the Committee and to every member, the greatest courtesy and consideration. He had not only taken great pains to explain all the matters that came before them, but he had always, most willingly, listened to any suggestions which any member of the Committee or the Council had desired to make, and he had given his most careful attention to those suggestions and was always ready to give advice and help.

In Sir John's resignation, the Society had lost an old, most loyal and valuable servant. The Council desired that in recognition of Sir John M'Fadyean's 40 years of honorary service to the Society that he should be elected a Life Governor and also that a piece of silver should be presented to him as a memento of his long association with the Society, and in appreciation of the long and loyal services he had rendered.

The above is a tribute paid by a great nobleman who had a very great knowledge of Sir John M'Fadyean's work and who was brought closely in contact with him and his work.

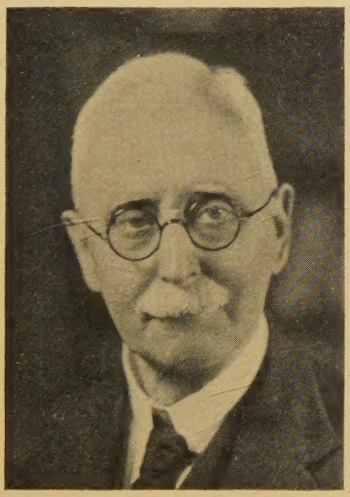
I do not think that anyone could pay a greater tribute to Sir John M'Fadyean, and I shall be glad if you will insert it as proposed in the *Journal of Comparative Pathology* now marking the 50th year of its publication.



An Appreciation.

By SIR THOMAS H. MIDDLETON,
K.C.I.E., K.B.E., C.B., D.Sc., LL.D., F.R.S.,
Vice-Chairman, Development Commission.

Although not a pathologist, I happen to be one of those whose bookshelves contain the, now somewhat scarce, early volumes of the *Journal of Comparative Pathology and Therapeutics*, and I welcome a reminder of the fact that for 50 years it has contributed to the progress of veterinary science and practice. For personal reasons, too, I am glad to have an opportunity of congratulating the Editor on the success of a publication which first appeared on March 31st, 1888. About that time, I happened to be present at a meeting in Edinburgh at which educational matters came up for discussion; seated near me was a tall, fair-haired young man who, on rising to speak, expressed himself in terms which to me seemed to show that his educational views were very sound. I ascertained that his name was John M'Fadyean. More than 20 years afterwards, I met M'Fadyean again, and again it was interest in education that brought us together. He was then Principal of the Royal Veterinary College, and he was intent upon improving the course of study followed by students of veterinary medicine. As in 1888, when he founded the journal, his objective was to advance the study of pathology by promoting research. Investigations were in progress at the College, but were sadly hampered by the lack of resources. A certain measure of assistance was secured from the Development Fund, thereafter an extended programme was adopted, substantial progress was made and plans were being discussed for the provision of a worthy Research Institute to accommodate the investigators who were being trained by the Principal, when war intervened. After the war, the subject was taken up again, but changed conditions resulted in long delays; thus a second 20 years passed before the Editor of the journal was assured of the facilities for research which those who refer to the editorials in the first volume will see that he had in view as early as 1888.



[*Bassano.*

It is not for me to comment on the great advances made in the pathology of domesticated animals since John M'Fadyean urged the importance of comparative studies and founded a journal for the purpose; but even those who have made no contribution to the subject must realise the changed position and must recognise that the State Veterinary Service now being organised has been made possible because of the improvement in professional qualifications which has resulted from the work of investigators and teachers of veterinary subjects during the period covered by the life of this journal. So that we may mark its own share on these changes it is interesting to look back and note some of its Editor's statements in presenting his first volume

to the profession. " The field of comparative pathology is immense and it is as yet in large measure unexplored." . . . "Every day brings forth new proofs of the immense importance of the comparative study of the pathology of man and that of the lower species " . . . " and may not a comparison of the morbid processes that take place in man and in the different species of domesticated animals, throw as much light on the special pathology of each species as the study of comparative physiology has shed on the functions of the human body." . . . " What may be called veterinary pathology is at the present time in a very crude state as compared with the pathology of man, and we wish to gather into our columns everything that will help to place it in a more advanced position." These and similar sentences show clearly what were the young Editor's purposes and plans 50 years ago; the single fact that this number completes a jubilee volume shows how well his objects have been accomplished.

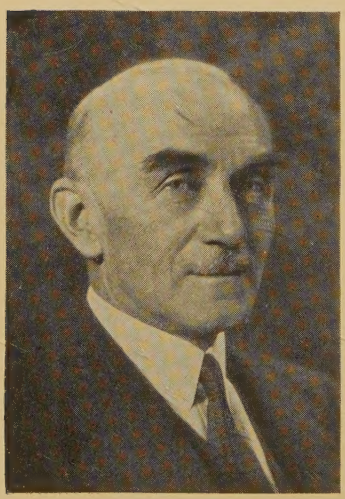
Alike for the enthusiasm which led to the issue of the first volume, for the steadfastness which carried the journal through the years to its 50th of issue and for the results which the publication has achieved, Sir John M'Fadyean deserves, and must get, congratulations, not only from professional colleagues, but from all interested in the improvement and health of domesticated animals.

Thomas H. Middleton

A Message from SIR JOHN KELLAND, M.R.C.V.S.,

Chief Veterinary Officer, Diseases of Animals Division, Ministry of Agriculture and Fisheries, London.

Founded 50 years ago at a transitional stage in the history of veterinary medicine, the *Journal of Comparative Pathology and Therapeutics* records the development, step by step, of veterinary bacteriology and pathology in the institutes in this country, in the Dominions and the Colonies, and in foreign countries. In recent years the State has founded new centres of research into diseases of animals but for a long time the only centre of investigation in Great Britain was at the laboratories of the Royal Veterinary College, Camden Town. The volumes of the journal reflect the work carried out there by its Editor on many subjects of outstanding importance to the British stock owner, some of which are diseases which the Government in the interests of the industry and of the nation has taken official cognisance. In addition, Sir John M'Fadyean has been still more closely associated with the work of the Diseases of Animals Division of the Ministry of Agriculture and Fisheries through the part he has taken in committees of



[*Elliot & Fry*

investigation into certain contagious diseases which are rigidly controlled by the State.

Only 3 years ago the State sponsored a scheme for the control of bovine tuberculosis, and it is possible to foresee the considerable impetus that is about to be given to this work by the creation of a National Veterinary Service which will begin to undertake the control of other diseases which take such a heavy toll of our livestock. It is appropriate to mention the inauguration of this service since it must be especially gratifying to Sir John M'Fadyean, as a former Principal and Dean of the Royal Veterinary College, as the Editor of a journal which has been the principal source of information on the development of bacteriology and the methods of control of contagious diseases, and as the pioneer of modern veterinary research in this country, to see the State, tardily, it may be, but nevertheless determined to encourage and assist stock owners to rid their herds of some of the most serious of the prevalent diseases.

With the publication of this last number of the current volume marking the close association of its Editor for half-a-century with the journal which he founded, it is sincerely hoped that in time to come his successors will be able to maintain the great value of this journal in the dissemination of knowledge to those engaged in various spheres of veterinary and other activities.

John Kellard

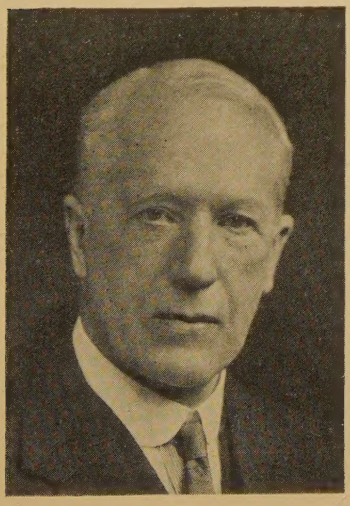
Sir John M'Fadyean's Contributions to Pathology :

An Intimate Appreciation.

By SIR ROBERT MUIR, M.A., M.D., Sc.D., LL.D., F.R.S.,

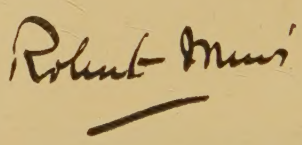
Emeritus Professor of Pathology, University of Glasgow.

My friendship with Sir John M'Fadyean, extending over 40 years, has been attended with an ever-increasing admiration for his powers and his work. Pathology has been his absorbing interest, as I think it has been the basis of his varied activities. I met him first at the meetings of the Edinburgh Pathological Club, which was founded in 1886, and which has been remarkable as a nursery for scientific workers. He was one of the earliest members and he had as his associates such men as W. S. Greenfield, G. Sims Woodhead, Alexander Bruce, D. Noel Paton, Byrom Bramwell, William Russell and others. The atmosphere was one of keen enquiry and his outlook was no doubt materially widened by the proceedings of the club. His friendship with Woodhead was of the closest kind; it was mutually helpful, led to co-operation and influenced the work of both. By the time Sir John left Edinburgh, in 1892, his accomplishments as a pathologist were generally recognised and were such as to ensure him future distinction in pathological science.



In the space at my disposal, I can give only some general impressions. Along with a fine technical equipment, he has a breadth of knowledge almost unknown in these days. Pathological anatomy and histology, bacteriology, the subject of viruses, infection and immunity—he has been conversant with them all. This is clearly evident from a survey of his numerous publications. Thus, for example, after having from him a series of important papers on tuberculosis, epizootic abortion, Johne's disease, etc., we meet with noteworthy investigations on nephritis in animals; this is a striking instance of his many-sidedness. All his published work has been of a high standard and, while most of his papers have a practical bearing, there are others of a more academic nature which have been stimulated by the spirit of scientific enquiry for its own sake, the spirit which has ever been the motive force in real advance. Another noteworthy feature is the soundness of his judgment; his natural critical faculty along with the due thought and observation which he gives to any subject has always made his opinion valuable and sought after. As the years go on, one's receptive faculty is apt to become blunted, but it has not been so in the case of Sir John M'Fadyean. His mind has remained wonderfully young, ever ready to receive new advances and estimate their value. When we were members together of the Foot-and-Mouth Disease Research Committee, I was struck again and again not only by his intimate knowledge of recent work, but also by his appreciation of the practical possibilities of new methods. If we consider the man and his work, how varied and valuable it has been, surely we have a picture and record which are almost unique. I should like to add how much I have enjoyed and valued his helpful friendship during these many years; it has been as unchanging as the granite of his native land.

I know well the high esteem in which Sir John is held by his brother-workers in human pathology, and I am sure that they would wish to join with me in offering him most cordial greetings at this time.



Sir John M'Fadyean's Contribution to Bacteriology:

An Appreciation.

By SIR JOHN C. G. LEDINGHAM,
C.M.G., F.R.C.P., F.R.S.
Director, Lister Institute of Preventive Medicine.
Professor of Bateriology, University of London.

Bacteriology knows no boundaries and I welcome the invitation to pay some small tribute in this Jubilee Commemorative Number of the *Journal of Comparative Pathology and Therapeutics*, to its Editor's services to the science in the veterinary sphere and in that ever-expanding territory common to it and to what by convention is called the medical field.

Sir John has been privileged in a long life to see the very beginnings of bacteriology in its relationship to infection and he has watched its rise and vast development from Louis Pasteur's essentially comparative handling of it, through periods of unnatural watertight specialism, to the now happily prevailing phase of reversion to the more catholic outlook that inspires its devotees.

It is, I think, correct to say that Sir John's own studies in the science have been in the main confined to problems concerned with the control of tuberculosis, contagious abortion and of glanders in our farm animals. In the prosecution of these studies he has been no mere bacteriologist. He has always displayed in his work the fullest understanding and appreciation of the pathological and histological implications of experiments on infection.

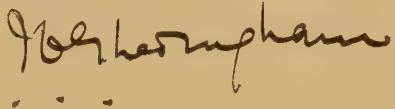
Noteworthy is Sir John's report (1907) on the occurrence of Johne's disease in England, a report later amplified in collaboration with Sheather and Edwards in the light of the successful results with the artificial cultivation of the causative organism obtained in the interval by Twort and Ingram.

At a time also when virus research was still in its infancy, Sir John was able to show for the first time (1900) that the virus of horse sickness was a filterable one. This was the second animal virus to which the filterability test was applied and found to hold.

The mere recital, however, of these and other individual pieces of bacteriological work accomplished by Sir John, barely reflects the long record of systematic investigations made by him and his associates at the Royal Veterinary College on a great variety of animal diseases during the first two decades of the present century or the influence exerted by his work and precepts on his many pupils now occupying important posts in veterinary pathology at home and abroad. As the doyen of veterinary pathology in this country, Sir John officiated as one of four Presidents of Honour at the Second International Congress for Microbiology in London in 1936, and in his address to the gathering he was able to look back to 1891 when he attended as a sectional officer the International Congress of Hygiene held in London, and to reflect on the vast progress since that time in our knowledge of the causation and control of animal disease.

Octogenarian and Editor, still in harness, clearly age has not dimmed his interest in a present, linked by a full memory with the past.

Ampliat ætatis spatium sibi vir bonus. Hoc est
Vivere bis, vita posse priore frui.

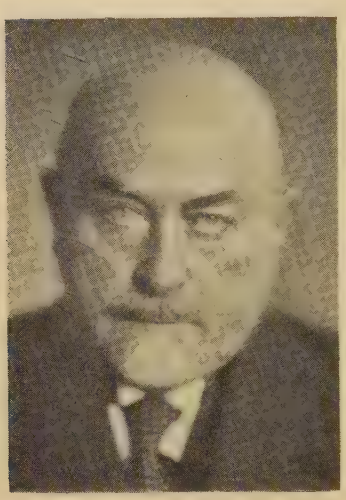


Zum 50 jährigen Bestehen von „ The Journal of Comparative Pathology and Therapeutics " und zu Ehren seines Herausgebers Sir John M'Fadyean.

Von PROFESSOR DR. ROBERT VON OSTERTAG,

Ministerialdirektor i.R. Tübingen ; Hon. Assoc., R.C.V.S.

Die Vollendung des 50. Jahrgangs der bedeutenden wissenschaftlichen tierärztlichen Zeitschrift „ The Journal of Comparative Pathology and Therapeutics " ist mir ein willkommener Anlass, zugleich mit der Würdigung dieses Ereignisses meiner Hochachtung und Bewunderung Ausdruck zu geben, die ich gleich so zahlreichen andern Tierärzten, insbesondere auch in Deutschland, für den grossen englischen Tierarzt Sir John M'Fadyean, den Reorganisator des tierärztlichen Unterrichts in Grossbritannien, den erfolgreichen Forscher, den unermüdlichen Förderer des tierärztlichen Standes und seiner öffentlichen Interessen und den ausgezeichneten, vornehmen Menschen, Ausdruck hege.



Es sind 46 Jahre her, dass ich das Glück hatte, den damaligen jungen Professor John M'Fadyean aus Edinburgh, der für das Londoner Veterinary College bestimmt war, kennenzulernen. Es war bei Gelegenheit einer Deutschlandsreise, die ihn auch nach Berlin führte, wo ich damals als Obertierarzt bei der Fleischbeschau am Städtischen Schlachthof tätig war. Professor John M'Fadyean besuchte bei seiner Anwesenheit in Berlin den Schlachthof, ebenso wie er die Schlachthöfe in Leipzig, Dresden, München, Stuttgart aus Interesse für die öffentliche Bedeutung dieser wichtigen Einrichtungen des tierärztlichen Gesundheitdienstes besucht hatte. Bei diesem Anlasse hatte er die Freundlichkeit, mich auf dem bevorstehenden VII. Internationalen Kongress für Hygiene und Demographie aufmerksam zu machen, der vom 20.-27. August 1891 in London stattfinden sollte, und mir während meines Aufenthalts in London seine freundschaftliche Unterstützung anzubieten. Dank dieser Aufforderung habe ich an dem Kongresse teilgenommen, wohnte mit Professor John M'Fadyean in Fords Hotel am Manchester Square und hatte so die erwünschte Gelegenheit, den gleichgesinnten, von hohen Idealen für die weitere wissenschaftliche Entwicklung der Tierheilkunde begeisterten Gelehrten näher kennen zu lernen.

Schon bei den Verhandlungen des Kongresses erhielt ich eine Probe seines wissenschaftlichen Streitertums, als er sich im Anschluss an einen Vortrag von Dr. Klein in London über ansteckende Euterkrankheiten der Kuh mit Bezug auf epidemische Krankheiten des Menschen gegen die unbewiesenen, experimentell nicht begründeten Behauptungen Kleins wandte, dass er Eutererkrankungen bei Kühen als Ausdruck einer spezifischen Erkrankung der Tiere an Scharlach und Diphtherie gesehen habe. Professor John M'Fadyean hatte die vorbehaltslose Zustimmung der Versammlung

und hat auch in der Folge recht behalten, da, abgesehen von einem einzigen Falle, keine Euterentzündung bei der Kuh gesehen worden ist, die durch Scharlach- oder Diphtherieerreger bedingt wurde. Unbeschadet der Tatsache, dass Scharlach und Diphtherie durch Milch infolge nachträglicher Verunreinigung der ermolkenen Milch mit Scharlach- und Diphtheriematerial zur Uebertragung gelangen können.

Beim Besuch des Londoner Veterinary College, das damals noch unter der Leitung des klugen und von Professor John M'Fadyean hochgeschätzten Dr. Brown stand, legte mir Professor M'Fadyean seine Ansicht über die Neugestaltung des tierärztlichen Unterrichts und der Forschung, die er auf eine streng wissenschaftliche Grundlage zu stellen sich vorgenommen hatte, dar. Und er hat diese Vorhaben glänzend erfüllt. Sir John M'Fadyean kann das höchste Lob des wissenschaftlichen Lehrers für sich beanspruchen, er hat Schule gemacht und tüchtige Lehrer und Forscher herangezogen, die sein Werk fortführen und der Tierheilkunde in Grossbritannien daheim und draussen unter der Führung ihres grossen Meisters eine Achtung gebietende Stellung verschafft haben.

Nach unserer Londoner Begegnung, die in meine Sturm- und Drangperiode fiel, und an die ich immer mit reiner Freude zurückdenke, habe ich das Schaffen und Wirken von John M'Fadyean aus der Ferne verfolgt.

Mit stets grossen Interesse habe ich seine wissenschaftliche Zeitschrift mit ihren wertvollen Beiträgen gelesen. Der junge Forscher hat die Zeitschrift in erster Linie auf die pathologische Anatomie abgestellt, die Grundwissenschaft für den Forscher und auch für den behandelnden Tierarzt. Die pathologische Anatomie gibt dem Forscher über Seuchen eine ganz andere Grundlage als die reine Bakteriologie. Mit Bedacht hat Sir John M'Fadyean sich auch die Bearbeitung der vergleichenden Pathologie zum Ziele gesetzt, die ihm, ursprünglich Arzt, besonders eindrucksvoll war, und von der die Menschen- und Tierheilkunde gegenseitige wichtige Anregungen empfangen. Er hat aber gleichzeitig auch die Interessen des praktischen Tierarztes berücksichtigt, indem er in seiner Zeitschrift auch der Therapie gleichberechtigten Raum gab. Sir John M'Fadyean hat im Anfang die Beiträge zu seiner Zeitschrift selbst bestritten, im Laufe der Jahre aber immer mehr junge fähige Mitarbeiter an seinem Journal herangezogen, das stets einen bedeutenden Rang unter den Zeitschriften der tierärztlichen Wissenschaft behauptet hat und behauptet. Wieviele wertvolle Anregungen hat die tierärztliche Welt dem „ Journal of Comparative Pathology and Therapeutics " entnommen, und es verdient grösste Anerkennung, dass Sir John M'Fadyean seine Zeitschrift ein halbes Jahrhundert lang ohne Hilfe geleitet und als ein rein privates Unternehmen durchgeführt hat. Mit der in dieser Zeitschrift geleisteten Arbeit hat der Herausgeber-Jubilar der Tierheilkunde in Grossbritannien und in der Welt einen Dienst erwiesen, der nicht hoch genug zu veranschlagen ist.

Als Lehrer habe ich Sir John M'Fadyean nicht kennen gelernt, aber ich weiss aus den begeisterten Schilderungen seiner Schüler in Britischen Kolonien, die ich bei meinen Reisen nach Südwest-, Süd- und Ostafrika kennen gelernt habe, welch ausgezeichneter Lehrer er gewesen ist. Eine Vorstellung hiervon erhielt man auch aus seinem bestimmten, überzeugenden Auftreten bei den internationalen tierärztlichen Kongressen und aus der Art der Schriftleitung seines „ Journal of Comparative Pathology and Therapeutics."

Als Forscher ist Sir John M'Fadyean weltbekannt. Von seinen zahlreichen wissenschaftlichen Erforschungen will ich nur Einiges Wenige, das ich im Lauf der Zeit verfolgt und noch in Erinnerung habe, hier anführen. Er hat gearbeitet insbesondere auf dem Gebiete der Erkennung und Bekämpfung der Tierseuchen, ausserdcin aber auch auf dem Gebiete der Parasitenkunde und der Fleisch- und Milc h-hygiene und nicht zuletzt über wichtige Fragen des kolonialen Veterinärwesens.

Er wandte seine Aufmerksamkeit allen wichtigen tierärztlichenTagesfragen zu, welche das wissenschaftliche und wirtschaftlich so wichtige Gebiet der Seuchenerforschung und Seuchenbekämpfung betrafen.

Ihm verdanken wir schon aus dem Jahre 1896 die wichtige Arbeit über die Serodiagnose des Rotzes nach dem Vorgange Vidals beim Typhus des Menschen, welche in der Folge die Methode der Bekämpfung des Rotzes wurde und in allen Ländern, in denen sie planmässig angewandt wurde, zur Ausrottung der Rotzkrankheit geführt hat. Jener Seuche, die man zuvor, da sie am lebenden Tier in vielen Fällen nicht erkennbar war, zu den notwendigen Uebeln der Pferdezucht und Pferdehaltung gerechnet hat. Mit Hilfe der Serodiagnostik ist es sogar im Weltkriege möglich gewesen, eine stärkere Ausbreitung der Rotzkrankheit zu verhüten.

Beim Milzbrand verdanken wir dem Jubilar eine neue Hilfsmethode zur Feststellung durch eine bestimmte Art der Färbung der Blutausstriche mit ei nprozentiger wässriger Methylenblaulösung.

Das bedeutendste Interesse wandte Sir John M'Fadyean wohl der Bekämpfung der Tuberkulose des Rindes zu. Im Jahr 1900 erschien seine grundlegende Arbeit über die Verbreitung der Tuberkulose unter dem englischen Rindvieh auf Grund der Prüfung mit Tuberkulin. Er hat damals in Bestätigung der Ermittlungen des dänischen Forschers Bang für England festgestellt, dass sich dort Herden von 30 und mehr Stück fanden, die vollkommen frei von Tuberkulose waren, während in andern Herden bis zu 80 Prozent der Tiere reagierten. Vorausgegangen waren Mitteilungen über angeborene Tuberkulose bei Kälbern mit sorgsamen pathologischanatomischen Befunden und der Feststellung, dass in den von ihm beschriebenen Fällen sich stets ein tuberkelbazillenhaltiges Exsudat zwischen den Chorionzotten und den Epithelien der Krypten befand. Zweifellos war er auch an der Arbeit der Kgl. englischen Tuberkulosekommission massgebend beteiligt, die 1896 zur Bekämpfung der Tuberkulose des Rindes forderte, dass öffentliche Schlachthäuser mit Schlacht- und Untersuchungszwang errichtet, Fleischbeschauer ausgebildet und Vorschriften über das Verfahren mit dem Fleisch und der Milch tuberkulöser Rinder erlassen werden sollen. Ausserdem verlangte die Kommission Zwangsbauvorschriften für die Kuhställe und möglichste Förderung der Tuberkulosetilgung unter den Rindern nach der damals allein bekannten Methode Bang. Alles Forderungen, die auch heute noch zu Recht bestehen.

Unvergessen ist Sir John M'Fadyean auch, dass er im Anschluss an die bekannten Mitteilungen von Robert Koch über die Beziehungen der Menschen zur Haustiertuberkulose auf dem Londoner Tuberkulosekongress im Jahre 1901 die Annahme einer Ungefährlichkeit der Haustiertuberkulose für den Menschen auf Grund der von Robert Koch mitgeteilten Verschiedenheit der Tuberkelbazillentypen des Menschen und des Rindes im Verein mit Lister, Sims Woodhead, Nocard, Bang u.a. als unschlüssig ablehnte und mit für den Schlussantrag eintrat, dass vorläufig an den bestehenden Bestimmungen über den Verkehr mit Fleisch und

Milch tuberkulöser Tiere nichts geändert werden dürfe. Die hierauf veranlassten Untersuchungen der Englischen Tuberkulosekommission, in der sicher auch Sir John M'Fadyean seinen Anteil hatte, haben mit andern in der Folge angestellten Untersuchungen gelehrt, wie richtig der Schlussantrag des Londoner Tuberkulosekongresses war, und dass eine gegenteilige Stellung geeignet gewesen wäre, Unheil hervorzubringen.

Sir John M'Fadyean hat sich auch mit der noch immer nicht gelösten Frage der Immunisierung von Rindern gegen Tuberkulose beschäftigt und den Aufsehen erregenden Erfolg erzielt, Rindern durch mehrfache Injektionen von Tuberkelbakterien eine so hohe Immunität zu verleihen, dass sie oftmals wiederholte intravenöse Einspritzungen sehr stark tuberkelbazillenhaltigen Materials ohne Reaktion ertrugen.

Auch bei der Paratuberkulose sahen wir Sir John M'Fadyean an der Arbeit und auf Grund seiner Untersuchungen die Ansicht vertreten, dass der Erreger der Paratuberkulose vom Kochschen Bazillus verschieden sei, und dass daher das Leiden als eine spezifische Krankheit der Rinder aufzufassen sei. Er hat auch den Vorschlag gemacht, die Krankheit nach ihrem ersten Beschreiber Johnes disease zu nennen, eine Bezeichnung, die sich in der englischen Literatur eingebürgert hat.

Es verstand sich von selbst, dass der umfassend rührige wissenschaftliche Arbeiter auf dem Gebiet der Tierseuchenbekämpfung sich auch mit der Erforschung und Bekämpfung der nach der Tuberkulose wichtigsten seuchenhaften Erkrankung des Rindes, dem Abortus, befasste. Er hat, um nur einiges hieraus zuerwähnen, zusammen mit dem ihm nahestehenden Schüler Professor Stockman festgestellt, dass der Bang-Striboltsche Erreger auch in England das seuchenhafte Verkalben hervorruft, gleichzeitig aber zusammen mit Stockman den zweiten spezifischen Erreger der seuchenhaften Abortus, den Vibrio fetus, entdeckt und mit Stockman in Beständen, in denen das seuchenhafte Verkalben durch den Abortus-Bazillus bedingt war, Bekämpfungsversuche mit einem „ Abortin " benannten Präparate durchgeführt, das sie aus 4-6 wöchigen Glyzerinbouillonkulturen des Abortusbazillus nach Art des Tuberkulins hergestellt hatten.

Dass sich Sir John M'Fadyean auch mit den Fragen der Schweineseuche und Schweinepest eingehend befasst hat, ist bekannt. Allgemeiner Zustimmung der englischen Tierärzte war er sicher, als er um die Jahrhundertwende dem Präsidenten des englischen Landwirtschaftsrats Hanbury, der in einer Versammlung der Kgl. Landwirtschaftsgesellschaft gesagt hatte, dass die Tierärzte nicht das ABC der Schweineseuche kennen, mit sachlichen Gründen entschieden entgegentrat. Die Aeusserung Hanburys sei unberechtigt. Wenn er sich bei Mitgliedern des tierärztlichen Standes informieren wolle, würde er vielleicht zu der Ueberzeugung kommen, dass der Misserfolg der behördlichen Massnahmen gegen die Seuche weniger der Unwissenheit der Tierärzte als dem hartnäckigen Verfolgen eines Verfahrens zuzuschreiben sei, welches die den Tierärzten bekannten Tatsachen verkenne.

Unvergessen ist auch die kritische Zurückweisung, die Sir John M'Fadyean den Mitteilungen Lignières' auf dem XI. Internationalen Tierärztlichen Kongress in London 1930 angedeihen liess, indem er ihm zur Abkürzung der nutzlosen Debatte über das von Lignières angeblich gefundene chemotherapeutische Präparat zur Bekämpfung der Maul- und Klauenseuche empfahl, mit seinem Mittel zunächst die Maul- und Klauenseuche in Argentinien, wo Lignières damals tätig gewesen war, zu tilgen.

Auch auf dem wichtigen Gebiete der tierischen Parasiten der nutzbaren Haustiere hat sich Sir John M'Fadyean betätigt. Er fand bei der Untersuchung von Rindern, die unter dem Symptomen der Diarrhoe, Abmagerung und Anaemie gestorben waren, im Labmagen zwei Strongylidenarten, von denen die eine wohl mit Ostertags Strongylus convolutus (Ostertagia ostertagi Stiles) identisch war, während die andere die M'Fadyean als Strongylus gracilis benante, als neue Art bezeichnet wurde.

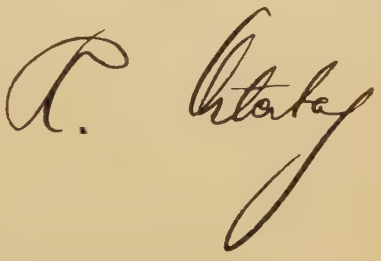
Sein Interesse für Fragen der tierärztlichen öffentlichen Gesundheitspflege hat Sir John M'Fadyean schon auf dem VII. Internationalen Kongress für Hygiene und Demographie in London 1891 bekundet, als er im Anschluss an einen Vortrag des Medical Officer Vacher, Birkenhead, über Fleischbeschau sich für baldige Einführung der Fleischbeschau aussprach, und bei dieser Gelegenheit der Einrichtung der deutschen Schlachthöfe begeistertes Lob spendete. Kurz darauf ist er für die Abschaffung der privaten Schlachthäuser und die allgemeine Einführung einer Fleischbeschau in öffentlichen, von den Gemeinden errichteten Schlachthusern warm eingetreten. Dadurch werde eine nicht geringe Menge ungesunder und verdorbener Nahrungsmittel vom Verkehre ausgeschlossen und ausserdem der Erzeuger geschützt, da er dann nicht mehr, wie dies ohne öffentliche Schlachthäuser oft der Fall sei, bei Feststellung geringfügiger krankhafter Veränderungen zur Schadloshaltung herangezogen werde.

Sir John M'Fadyean war auch an den Vorarbeiten zu dem sehr guten englischen Milchgesetz und an dessen endgültiger Abfassung beteiligt. Ich erinnere an den Bericht M'Fadyeans über die im Jahre 1898 eingesetzte Kgl. Kommission über die Verhütung der durch den Genuss von Milch entstehenden Gefahren durch gesetzliche Massnahmen. Die Kommission hat bekanntlich vorgeschlagen: 1. Systematische Untersuchung und Beaufsichtigung der Milchkühe, 2. Verbot des Verkaufs der Milch von Kühen mit Erkrankung des Euters oder klinischen Symptomen der Tuberkulose, 3. Strafbestimmungen gegen das Feilhalten der Milch von Kühen, die an Eutererkrankung leiden, sofern der Eigentümer nicht ein tierärztliches Zeugnis darüber besitzt, dass die Erkrankung nicht tuberkulöser Natur ist, 4. Anzeige jeder Eutererkrankung bei Kühen in Molkereien. Lauter ausgezeichnete Vorschriften.

Ein besonderer Rumhestitel für Sir John M'Fadyean sind seine Beteiligung an der Bekämpfung tropischer und subtropischer Tierseuchen und die Heranbildung eines ausgezeichneten Stabes von Tierärzten für den kolonialen Veterinärdienst. Er hat im Verein mit Sir Arnold Theiler und Professor Stockman das hohe Verdienst, durch planmässige Schutzimpfung der nach der südafrikanischen Union zur Ausfuhr gelangenden Milch-Rasserinder die Schaffung zahlreicher Rein- und Kreuzungsherden ermöglicht zu haben, auf denen der heutige hohe Stand der Milchwirtschaft in der südafrikanischen Union beruht. Um diesen hohen Stand der Rindviehhaltung in der südafrikanischen Union zu beleuchten, brauche ich nur anzuführen, dass ich, als ich 1910 in Südafrika war, in meinem Gasthof in Kapstadt gefrorene australische Butter und dänische Büchsenbutter zu den Mahlzeiten bekam, und dass heute die südafrikanische Union bereits ein regelmässiger Belieferer des englischen Marktes mit Butter und Käse ist. Es bestehen zur Zeit in der Union 59 registrierte Buttereien, 26 Rahmstationen, 105 Käsereien, 5 Progresskäsereien und 4 Fabriken zur Herstellung von kondensierter Milch. Die Ausfuhr aus der Union betrug 1936 9,304,746 lbs. Butter und 1,353,911 lbs. Käse. Kann man sich einen schöneren Erfolg einer wissenschaftlichen Tätigkeit wünschen?

Der Begründer und Schriftleiter des „ Journal of Comparative Pathology and Therapeutics „ Sir John M'Fadyean kann mit dem Gefühle hoher Befriedigung auf sein an Arbeit, aber auch an Erfolgen reiches Leben zurückblicken. Unser gemeinsamer Freund Professor Emmanuel Leclainche hat der hohen Wertschätzung, deren sich John M'Fadyean in der Welt erfreut, bei Eröffnung des XI. Internationalen Tierärztlichen Kongresses in London im Jahre 1930 dadurch Ausdruck verliehen, dass er den Kongress unter allgemeiner Zustimmung als „ M'Fadyean Kongress " bezeichnete.

Ich beglückwünsche Grossbritannien zu diesem glänzenden tierärztlichen Führer und wünsche Sir John M'Fadyean selbst noch viele Jahre seiner so nützlichen Tätigkeit als Herausgeber des „ Journal of Comparative Pathology and Therapeutics " und als sonstiger Betreuer der Tierheilkunde, der sein Herz gehört. Ich bin mir hierbei der Zustimmung der deutschen Tierärzte sicher !



A Contribution to the Fiftieth Anniversary of " The Journal of Comparative Pathology and Therapeutics " in honour of its Editor, Sir John M'Fadyean.

By Professor Robert von Ostertag,
Ministerial Director, Tübingen ; Hon. Assoc., R.C.V.S.

The completion of the fiftieth year of the important scientific veterinary periodical, *The Journal of Comparative Pathology and Therapeutics*, affords me a welcome opportunity not only to recognise this achievement but also to express my admiration and esteem, shared by so many other veterinarians, particularly in Germany, of the great English veterinarian, Sir John M'Fadyean. He has reorganised veterinary education in Great Britain, has been a successful research worker, and has always been untiring in his efforts to improve the status of the veterinary profession.

I was first privileged to meet Sir John M'Fadyean 46 years ago when he was a professor at Edinburgh. During his travels in Germany, he visited the abattoir in Berlin where I was at the time Chief Veterinary Inspector. Professor M'Fadyean's interest in the important part played by the abattoir in the veterinary health service had already taken him to the slaughter-houses at Leipzig, Dresden, Münich and Stuttgart. On that occasion he very kindly told me of the forthcoming Eighth International Congress of Hygiene and Demography which was to be held in London from August 20th to 27th, 1891, and offered me his hospitality during my stay in London. Thanks to this invitation, I was enabled to attend the congress and had the pleasure of staying with Professor M'Fadyean at Ford's Hotel, Manchester Square. Thus I had the opportunity of getting to know more intimately a great man of learning and one imbued with high ideals of the future development of veterinary science.

During the proceedings of the congress I was given an insight into Professor M'Fadyean's powers of scientific reasoning when, at the conclusion of a paper by Dr. Klein on infectious bovine mastitis in relation to epidemics of disease in man, he objected to the entirely unjustified conclusions of the reader of the paper to the effect that udder disease in the cow was referable to specific infection of the animal with scarlet fever and diphtheria. Professor M'Fadyean's remarks received the full support of the meeting and, with the exception of a single case, subsequent work has failed to show that bovine mastitis is produced by the causal agent of scarlet fever or

diphtheria. This does not of course alter the fact that these two diseases may be transmitted to man by subsequent contamination of milk after it leaves the cow, with infective material from human beings.

The veterinary college in London was at that time under the direction of Dr. Brown, a man whom Professor M'Fadyean held in high esteem. During my visit to the college Professor M'Fadyean told me his views on the reorganisation of veterinary education and research which he intended to establish on a strictly scientific basis. That task he has indeed brilliantly fulfilled ! Sir John M'Fadyean can lay claim to the greatest achievement of the teacher of science ; he reorganised a college and attracted to it as teachers and research workers capable men who are carrying on his work both within and outside the British Isles and who, under the guidance of their able teacher, have elevated veterinary science to a commanding position.

It has often given me pleasure to recall our meeting in London, at a time when my life was full of hurry and bustle. Since then I have followed the work and activity of Sir John M'Fadyean at a distance.

I have always been very interested to read the pages of his scientific journal, filled with valuable contributions. As a young research worker, he established the journal on a basis of pathological anatomy as forming the fundamental science for both the man in research and in practice. Pathological anatomy gives the research worker a completely different outlook on contagious disease from that conveyed by pure bacteriology. Very wisely, Sir John M'Fadyean also laid stress on the consideration of comparative pathology, a subject which, in his original capacity as a medical man, particularly impressed him, and from which both human and veterinary science can derive important mutual benefits. At the same time, however, he assigned to therapeutics its rightful place in his journal and so supplied the needs of the veterinarian in practice.

At first, Sir John M'Fadyean himself prepared the contributions to the journal ; in the course of the years, however, he called in more and more able young colleagues as contributors to his journal and it has always held, and to-day still holds, an important place among the journals devoted to veterinary science. The *Journal of Comparative Pathology and Therapeutics* has provided the world of veterinary science with a wealth of stimulating material and great credit is due to Sir John M'Fadyean for having continued it unaided for half a century, purely as a private enterprise. The editor, now celebrating the jubilee of his journal, has performed a service to veterinary science in Great Britain and the world, the importance of which cannot be sufficiently highly estimated.

I have never known Sir John M'Fadyean in his capacity as a teacher but during my travels in South-West, South and East Africa I have heard the enthusiastic descriptions of his former pupils, at that time in the British Colonial Service. Further evidence of this ability as a teacher was provided by his attendance at the international veterinary congresses and by the character of his editorial management of the *Journal of Comparative Pathology and Therapeutics*.

As a research worker, Sir John M'Fadyean's reputation is world-wide. I can mention here only a few of his numerous scientific contributions.

In particular, he worked in the field of diagnosis and control of infectious diseases in animals, but also in parasitology and in meat and milk hygiene ; last, but not least, was his work in the sphere of colonial veterinary administration. He devoted his attention to all the important veterinary problems of the time dealing with research into and the control of infectious diseases ; problems of scientific and economic importance.

We owe to him valuable work on the serological diagnosis of glanders published in 1896. The procedure employed, based on Widal's method used in human typhoid, became the method of control in all countries, and wherever it has been systematically applied, it has resulted in the stamping out of a disease which had formerly been considered as one of the inevitable scourges accompanying the breeding and keeping of horses ; particularly since it was often not possible to diagnose it in the living animal. With the help of serological diagnosis it was possible even to prevent the further spread of glanders during the World War.

We have to thank him, too, for an aid to the diagnosis of anthrax by a special staining method, using a 1 per cent. solution of methylene blue.

Sir John M'Fadyean turned his attention in particular to the control of bovine tuberculosis. In the year 1900, there appeared an important paper dealing with the incidence of tuberculosis in English cattle on a basis of the tuberculin test. In this paper, he showed that the earlier findings of Bang in Denmark applied to England and that there existed herds of 30 cows and over which were completely free of tuberculosis, whereas, in other herds, up to 80 per cent. of the animals might react to

tuberculin. This work had already been preceded by a study of congenital tuberculosis in calves, which included a careful consideration of the pathological anatomy of the condition and a description of the constant finding of an exudate containing tubercle bacilli between the chorionic villi and the epithelium of the crypts. In the work of the English Royal Commission on Tuberculosis he doubtless played an important part. As a result, the control of bovine tuberculosis was investigated, public abattoirs were constructed with facilities for slaughtering and inspection, meat inspectors were trained, and legislation for dealing with tuberculous milk and meat was evolved. In addition, the Commission demanded the controlled planning of cowsheds and the carrying out as far as possible of tuberculosis eradication according to the method devised by Bang ; at that time, the only method. The wisdom of each of these steps is clearly seen to-day.

One must not forget Sir John M'Fadyean's opposition to the views put forward by Robert Koch at the Congress for Tuberculosis in London in 1901. Koch, in company with Lister, Sims Woodhead, Nocard, Bang and others, considered bovine tubercle bacilli to be harmless to man in view of the difference between the human and bovine types of the organisms. M'Fadyean stated that for the present the precautions to be taken when dealing with tuberculous meat and milk should be maintained. The subsequent findings of the Royal Commission on Tuberculosis, in which Sir John played an important part, as well as later work, have confirmed his views propounded at the Tuberculosis Congress, and shown that a contrary attitude could only have caused disaster.

Sir John M'Fadyean also studied the problem of immunisation of cattle to tuberculosis—a problem still awaiting solution. He was able [in cattle that had reacted after] by repeated intravenous injection of tuberculin, to produce an immunity of such a degree that the animals were able to withstand, without reacting, repeated intravenous injections of highly infective tuberculous material.

The subject of paratuberculosis also claimed Sir John M'Fadyean's attention and, as a result of his work, he concluded that it constituted a specific disease of bovines distinct from tuberculosis. He named the disease " Johne's Disease " after its discoverer, and this name has taken its place in English literature.

It was natural that this ever active research worker should turn his attention to the infectious disease which, next to tuberculosis, was the most important affecting bovines—abortion. To mention but a small part of his contribution, he established, in collaboration with his friend and pupil, Professor Stockman, that the Bang-Stribolt organism was one cause of infectious abortion in England, and also that a further specific ætiological agent was *Vibrio fœtus*.

With Stockman, he carried out [preliminary] attempts at control of infectious abortion, in herds where it was caused by the " abortion bacillus," by the injection of a preparation which he called " Abortin " [for diagnosis] ; this was prepared in a similar manner to tuberculin from 4 to 6-week-old cultures of the organism in glycerin broth.

It is well known that Sir John M'Fadyean also turned hs attention to the problem of swine plague and swine fever. He voiced the general opinion of English veterinary surgeons when, about the end of the last century, he firmly opposed the remarks of Mr. Hanbury, President of the Board of Agriculture, at a Meeting of the Central and Associated Chambers of Agriculture [see this Journal, 1891, **14**, 361], to the effect that the veterinary surgeon did not know the ABC of swine fever. Sir John M'Fadyean replied that Hanbury would wish to alter his opinion if he would confer with representatives of the veterinary profession. He would then perhaps conclude that the failure of the official measures taken to combat swine fever was due, not to the ignorance of the veterinary surgeon, but to the obstinate pursuance of a policy opposed to the facts familiar to the veterinarian.

It is impossible to forget Sir John M'Fadyean's critical reply to the communication of Lignières at the Eleventh International Veterinary Congress in London in 1930. He appealed for the shortening of the useless discussion on the [undisclosed] agent which Lignières claimed to have found for the control of foot-and-mouth disease. He advised him to try it out first in the Argentine where the disease was existent and where Lignières was then working.

Sir John M'Fadyean worked, too, in the field of animal parasites affecting the larger domestic animals. In cattle dying following symptoms of diarrhœa, emaciation and anæmia, he found two species of strongyle in the abomasum—one of these was doubtless Ostertag's *Str. convolutus* (*Ostertagia ostertagi* Stiles), whilst the other was considered a new species and was named by Sir John M'Fadyean *Str. gracilis*.

At the Seventh International Congress for Hygiene and Demography held in London in 1891, Sir John M'Fadyean showed his interest in the Veterinary Public

Health Service in a reply to a paper by Dr. Vacher, Medical Officer for Birkenhead, proposing the immediate introduction of meat inspection. Sir John M'Fadyean then took the opportunity of praising the German abattoirs. Shortly afterwards, he pressed strongly for the abolition of private slaughterhouses and the general introduction of meat inspection in abattoirs governed by the local authorities. In that way a large amount of unwholesome food would be excluded from sale and, furthermore, the producer would be protected since he would no longer be held responsible for heavy damages in cases where slight evidence of disease was found, a common occurrence in the absence of public abattoirs.

Sir John M'Fadyean played a part in the preparation of the original English milk legislation and its final drafting. I recollect his report on the Royal Commission appointed in 1898 to devise regulations for the prevention of dangers arising from the consumption of milk. The Commission had recommended: (1) Systematic examination and inspection of milking cows. (2) Prohibition of the sale of milk from cows with udder disease or showing clinical symptoms of tuberculosis. (3) Penalties for selling milk from cows affected with udder disease in cases where the owner is not in possession of a veterinary certificate to the effect that the disease is not of tuberculous nature. (4) Notification of every case of udder disease in dairy cows. All really excellent recommendations!

Sir John M'Fadyean devoted special attention to the control of tropical and subtropical infectious diseases and to the building up of an excellent staff of veterinarians for the Colonial Veterinary Service. With Sir Arnold Theiler and Sir Stewart Stockman, he earned high praise for the systematic protective inoculation of milch cattle exported to South Africa and from which have since been produced numerous pure breeds and crosses which to-day form the basis of the milk industry in the Union of South Africa. As an example of the present state of cattle farming in the Union, I may perhaps mention that when in 1910 I was staying at an hotel in Cape Town, I was given frozen Australian butter and Danish tinned butter for meals. To-day, on the other hand, the Union is a regular exporter of butter and cheese to the English market. There are in the Union 59 registered butter factories, 26 cream factories, 105 cheese factories, and 4 factories for the production of condensed milk. The export from the Union in 1936 was 9,304,746 lb. of butter and 1,353,911 lb. of cheese. Could one wish for a better example of the success that attends scientific ability?

The founder and editor of the *Journal of Comparative Pathology and Therapeutics* can rightly look back with a feeling of intense satisfaction on a life during which so many tasks have been successfully undertaken. Professor Emmanuel Leclainche, a friend of us both, gave expression to his esteem for Sir John M'Fadyean when, with universal approval, he described the Eleventh Veterinary Congress in London in 1930 as "M'Fadyean's Congress." I congratulate Great Britain on its illustrious veterinary leader, Sir John M'Fadyean, to whom I tender a wish that he may for many years to come continue his valuable service as editor of the *Journal of Comparative Pathology and Therapeutics* and as a devoted friend of veterinary science, tasks which are so near to his heart. In expressing this sentiment I am voicing the wish of all German veterinarians. [E. G. White.]

A Supplementary Message from Germany.

Geh. Reg.-Rat. Dr.*h.c.*, DR. REINHOLD SCHMALTZ,

Professor emeritus der Universität zu Berlin, Redacteur der „Berliner tierärztlichen Wochenschrift;" Hon. Assoc., R.C.V.S.

Meinem Landsmann Robert von Ostertag kann ich mich nur mit wenigen Worten anschliessen. Seit einem Jahrzehnt von meinem Institute getrennt, vermag ich nicht mehr eine wissenschaftliche Arbeit zu liefern, die würdig wäre, in dieser Festschrift zu erscheinen. Ich möchte aber auch nicht an dieser Stelle fehlen, da ich mich den englischen Collegen besondersverbunden fühle als altes Ehrenmitglied des Royal College of Veterinary Surgeons. Ich komme auch nicht für mich allein, sondern als Begründer und Redacteur der „Berliner tierärztlichen Wochenschrift," die sich ebenfalls im 50. Jahrgange

befindet und durch Jahrzehnte in Deutschland die tierärztlichen Angelegenheiten führend vertreten hat, bin ich berechtigt, im Namen der deutschen Tierärzte Sir John M'Fadyean zu huldigen am Abschluss des 50. Jahrganges des von ihm geschaffenen „Journal of Comparative Pathology and Therapeutics."

Die Verdienste Sir John M'Fadyeans im einzelnen zu schildern, muss seinen englischen Zeilgenossen vorbehalten bleiben. Den deutschen Tierärzten gilt er als der glänzende Repräsentant des Veterinärwesens in Gross Britannien. Uber dessen Grenzen hinaus hat Sir John M'Fadyean sich dadurch ein besonderes Verdienst erworben, dass er die Teilnahme der englischen Collegen an den internationalen tierärztlichen Congressen ausserordentlich gesteigert hat durch sein Beispiel und dass er 1930 dem Congresse in London eine glänzende, alle Teilnehmer begeisternde Aufnahme bereitet hat.

Indem wir deutschen Tierärzte heute Sir John M'Fadyean zum Jubiläum seines so hervorragenden und erfolgreichen Journals beglückwünschen, geben wir auch dem Wunsche Ausdruck, dass Sir John, in diesem Jahre an dem Congresse in Zürich teilnehmen möge, um die Huldigungen seiner Verehrer aus aller Welt persönlich empfangen zu können.

REINHOLD SCHMALTZ, DR.MED.VET.,
Emeritus Professor at the University of Berlin,
Editor of the "Berliner tierärztliche Wochenschrift"; Hon. Assoc., R.C.V.S.

I CAN add but a few words to those of my fellow countryman, Robert von Ostertag. As I have been away from my institute for some ten years, I feel unable to submit a scientific paper worthy of publication in this Commemoration Number. I should not like to be completely absent at this time, however, for as an honorary associate of the Royal College of Veterinary Surgeons I feel bound by close ties to my English colleagues. I am expressing the feelings not only of myself but, as founder and editor of the *Berliner tierärztliche Wochenschrift* which is also now in its fiftieth year, having represented veterinary science in Germany for so long, I am voicing the wish of all German veterinarians in congratulating Sir John M'Fadyean on the fiftieth anniversary of the *Journal of Comparative Pathology and Therapeutics* which he founded.

A description of the services rendered by Sir John M'Fadyean must be left to his English colleagues: to German veterinarians he stands as the illustrious leader of veterinary science in Great Britain. Far beyond the confines of his own country Sir John M'Fadyean has acquired a great reputation especially as, by his example, he has enormously increased the part played by his English colleagues at the International Veterinary Congresses. And because, at the Congress held in London in 1930, he arranged for all those who took part a most brilliant and enthusiastic reception.

In offering to Sir John M'Fadyean our congratulations on the jubilee of his distinguished and successful journal, may we add a sincere wish that Sir John may take part in the next International Congress at Zürich in the coming year where his admirers from all parts of the world may offer him personally their congratulations and respects. [E. G. WHITE.]

A Tribute from France.

By PROF. E. LECLAINCHE,

Directeur de l'Office International des Epizooties, Paris; Président de l'Académie des Sciences; Directeur honoraire au Ministère de l'Agriculture; Hon. Assoc., R.C.V.S.

Il y aura cinquante années dans quelques semaines que le Professeur M'Fadyean, du Dick's College d'Edimbourg, créait The Journal of Comparative Pathology and Therapeutics. Le premier numéro est daté du 31 Mars 1888. Il débute, sans avis au lecteur, par une excellente étude du fondateur sur The Pathology of Hemoglobinuria of Horses. Les Ecossais pensent et agissent beaucoup plus qu'ils ne parlent: C'est par l'importance des travaux publiés, articles originaux ou traductions de toute origine, que va s'affirmer et s'imposer une publication qui se classe aussitôt parmi les meilleurs organes de notre littérature professionnelle.

Le journal est consacré tout entier à la science et je ne connais guère qu'une exception à la règle. En 1923, M'Fadyean reproduit le discours qu'il a prononcé le 23 Novembre de cette année, à la celebrations du centenaire du Royal (Dick) Veterinary College, Edinburgh. Dans cette Revue sur les progrès de la science vétériniare dans la Grande Bretagne pendant les cent dernières année, il rend un double hommage à sa profession et à celui qu'il considère, à juste titre, comme un précurseur et un apôtre, l'Ecossais William Dick. Elève de Coleman au Collège de Londres, Dick obtenait son certificat, le 27th Janvier 1818, après moins de quatre mois d'études. Il était alors dans la vingt-cinquième année de son âge.

On a reproché bien des choses à Coleman dans son propre pays. Cependant comme il apparaît autrement sympathique que son féroce adversaire Bracy-Clark, et le fait qu'il libère après quelques mois un pupille aussi exceptionnel que Dick montre que s'il avait peu de considération pour ses élèves habituels, il savait au moins faire un choix parmi eux.

Après avoir déploré l'indifférence des gouvernements anglo-saxons à l'égard de la médecine vétérinaire qu'ils abandonnent à ses propres forces, après avoir constaté qu'en dépit des exhortations de John Hunter et comme au temps de Végèce, l' "ars veterinaria post medicinam secunda est," M'Fadyean rend hommage à tous ceux qui ont contribué à ses progrès et il ajoute " . . . I think if any one acquainted with the history of veterinary science in this country since its foundation were asked to name in order those who have made the largest individual contributions to its advancement he would without hesitation place William Dick at the head of the list."

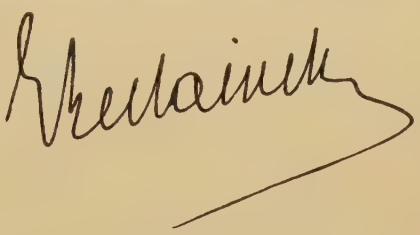
Ce jugement s'applique mieux encore à M'Fadyean lui-même. Pendant plus d'un demi-siècle, il a personnifié aux yeux du monde la science vétérinaire du Royaume-Uni. Il a vécu toute la " grande époque " qui a

suivi les découvertes de Pasteur et de Koch. Il reste l'unique représentant de la plus brillante période qu'ait connue notre médecine et son nom restera pour toujours associé à ceux de nos gloires disparues.

Si son oeuvre scientifique le classe parmi les premiers pathologistes de l'époque, son rôle professionnel lui mérite la reconnaissance non seulement de ses compatriotes, mais des vétérinaires du monde entier.

Il appartient au Collège de Londres pendant trente-huit années, comme professeur, puis comme Principal et Doyen, et il multiplie les preuves de son dévouement à la profession qu'il a librement choisie. S'il n'a pu vaincre, malgré toute son énergie et toute son autorité, l'inexplicable indifférence des pouvoirs publics à l'égard de l'enseignement vétérinaire, il contribue au moins à l'obtention d'importantes créations et il a la satisfaction d'assister maintenant au magnifique développement de la recherche scientifique dans le domaine vétérinaire. Déjà sous sa direction le laboratoire de pathologie vétérinaire du Collège de Londres était organisé, tandis que le toujours regretté S. Stockman obtenait la création et la direction du bel établissement de Weybridge.

Le Congrès de Londres, "the M'Fadyean's Congress," a permis aux professionnels du monde entier d'apporter à notre doyen vénéré l'hommage de leur affectueuse vénération. Je souhaite une survie indéfinie au journal qu'il inspire et qui célèbre à cette heure son premier cinquantenaire. J'adresse à Sir John le très respectueux hommage de ma cordiale sympathie.



A Tribute from France.

By Prof. E. Leclainche,

Director of the International Office of Epizootics, Paris;
President of the Academy of Sciences, and
Honorary Director to the Ministry of Agriculture;
Hon. Assoc., R.C.V.S.

In a few weeks' time it will be 50 years since Professor M'Fadyean, of Dick's College, Edinburgh, founded the *Journal of Comparative Pathology and Therapeutics*. The first number bears the date March 31st, 1888. It opens, without any preliminary note or preface, with an excellent study by the Editor on the Pathology of Hæmoglobinuria of Horses. The Scots think and act, much more than they talk, and this publication, which took its place at once among the best organs of our professional literature, was to make its name and reputation solely by the importance of the works it would publish, whether original articles or translations from foreign journals.

The journal was devoted entirely to scientific articles, abstracts and reviews, and I know of only one exception to this rule. In 1923 M'Fadyean reproduced the address he gave on November 23rd of that year at the centenary celebrations of the Royal (Dick) Veterinary College, Edinburgh. In this "Review of the Progress of Veterinary Science during the past hundred years," he pays tribute both to his profession and to him whom he justly considers a forerunner and an apostle, the Scotsman, William Dick. A pupil of Coleman at the London College, Dick obtained his certificate on January 27th, 1818, after less than four months' study. He was then in his 25th year. Coleman has been reproached in his own country for many things, but how much more sympathetic he appears to have been than his ferocious adversary, Bracy Clark, and the fact that he sent out after a few months a pupil so exceptional as Dick, shows

that, if he had little consideration for his ordinary pupils, he knew at least how to choose among them.

After deploring the indifference of the British Government in relation to veterinary medicine, which they left entirely to its own resources, and after having shown that in spite of the exhortations of John Hunter the *ars veterinaria post medicinam secunda est*, as it was in the time of Vegetius, M'Fadyean proceeds to honour all those who have contributed to its progress, and he adds " I think if anyone acquainted with the history of Veterinary Science in this country since its foundation were asked to name in order those who have made the largest individual contributions to its advancement, he would without hesitation place William Dick at the head of the list."

This judgment applies still more justly to M'Fadyean himself. For more than half a century he has personified in the eyes of the world the veterinary science of the United Kingdom. He has lived throughout the whole of the *grande epoque* which followed the discoveries of Pasteur and Koch. He remains the sole representative of the most brilliant period which our science has known and his name will remain for ever associated with those who have brought renown to our profession.

Just as his scientific work places him among the foremost pathologists of our time, his work for the advancement of his profession has earned for him the gratitude not only of his compatriots but of the veterinary surgeons of the whole world.

He was at the Royal Veterinary College for 38 years, first as Professor, then as Principal and Dean, and there he multiplied the proofs of his devotion to the profession of his choice. If he was not able to overcome, in spite of all his energy and authority, the inexplicable indifference to veterinary education of the powers that be, he contributed at least to the creation of important institutions and he still has the satisfaction of helping in the magnificent development of research in the domain of veterinary science. Under his direction the Research Institute in Animal Pathology at the London College was organised, whilst the ever lamented Sir Stewart Stockman succeeded in obtaining the establishment at Weybridge of the fine laboratory of which he was Director.

The International Congress at London, " M'Fadyean's Congress," gave the members of the profession throughout the whole world an opportunity of paying our revered Doyen the homage of their affectionate veneration. I wish a long future to the journal which he inspires and which is now celebrating its first jubilee. To Sir John I offer the very respectful homage of my cordial sympathy. [Fred Bullock.]

E. LECLAINCHE.

The United States appraises Sir John M'Fadyean and His Work.

By DR. JOHN R. MOHLER,

Chief, Bureau of Animal Industry, United States Department of Agriculture ; Hon. Assoc. R.C.V.S.

" As one lamp lights another and grows no less
So nobleness enkindles nobleness."

The sentiment in these lines illustrates the influence of Sir John M'Fadyean on veterinary enlightenment and the development of stock raising in the United States. As I write this appreciation of Sir John and his work, I have before me upwards of a hundred library references to his technical writings, editorials, and addresses covering a vast range of subjects with which he has dealt during the last half century. These reference cards are well worn, showing constant use by our scientific staff. The scope of his researches would do justice to a vast organization, and it seems scarcely credible that one man has been so versatile. The mere indexing of subjects which he has studied exhaustively requires most of the alphabet. The geographical application is world-wide.

From a scientific standpoint one promptly observes that Sir John has delved not only into pathology and therapeutics, but has explored also

bio-chemistry, immunology, parasitology and related scientific territory. More than that, it is noteworthy that he has not been content with challenging minor foes of the animal world, but has selected for scientific attack most of the major livestock enemies. Anthrax, blackleg, cancer, glanders, hog cholera, epizootic abortion, pneumonia, tuberculosis, and many others have been the objects of his aggressive attack.

Moreover, Sir John M'Fadyean emerges from his exploits in scientific pioneering as a leader in modern thought. The modern concept of effective veterinary work centers on sanitary and other preventive procedures—and I think of Sir John M'Fadyean largely as a livestock sanitarian. He had paid particular attention to prophylactic measures. Among his classical studies are those on preventing contamination of milk by pathogenic organisms, prompt diagnosis of diseases in their early stages, and protective immunization.

Here in the United States we have looked upon Sir John's work as dependable bedrock on which to build. In much the same manner that the livestock industry of the United States has been developed from imported breeding stock, our progress in veterinary science also is based in large degree on results of research abroad. The application of such research, however, must necessarily fit our own conditions of livestock care and management.

Sir John's work on animal tuberculosis and its relation to man occupies many pages, yet the essential facts are known to research workers of the United States and in addition are utilized in projects conducted by our regulatory officials. The extensive project by which bovine tuberculosis is rapidly being eradicated in this country rests on a foundation that the mind and hand of Sir John helped to build. His work on glanders also contributed greatly to the success of the United States in bringing this disease first under control and finally under its present condition of practical eradication. In similar manner he prepared the way for present-day projects against other bacterial and parasitic diseases that are proving vulnerable to scientific attack.

Besides Sir John M'Fadyean's attainments as an investigator and teacher, his executive ability is well known to his contemporaries in the United States. As President of the Eleventh International Veterinary Congress, held in London in 1930, Sir John became known personally to delegates from various countries including the United States. His combined executive and scientific genius is apparent also in the *Journal of Comparative Pathology and Therapeutics* which he founded and has edited so many years.

Besides speaking on behalf of the Federal Bureau of Animal Industry, I add my personal tribute to his unfailing courtesy and graciousness toward his contemporary workers. The cordial relations which are apparent between the veterinary profession of the United States and that of Great Britain have been to a material degree the product of his untiring co-operation.

Thus in many capacities Sir John M'Fadyean has been a leader in upbuilding and safeguarding the livestock industries of his own and other

nations. Although devoted to scientific research, he has been equally zealous in sharing his new-found knowledge with colleagues throughout the world. It is a privilege on this occasion to extend to Sir John M'Fadyean my continued expressions of esteem with the hope that for many additional years he may witness the increasing fruits of his scientific labors.

A Message from Canada.

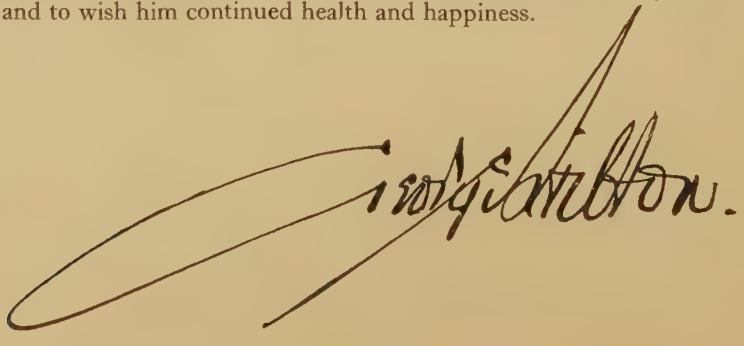
By DR. GEORGE HILTON,

Veterinary Director-General of Canada, Department of Agriculture, Ottawa, Ontario; Hon. Assoc., R.C.V.S.

Learning that the December issue of the *Journal of Comparative Pathology and Therapeutics* will complete the 50th Volume of that journal, veterinarians in Canada join with the profession in other countries in offering Sir John M'Fadyean, its founder and editor during that long period, the heartiest congratulations.

While, comparatively speaking, few Canadian veterinarians have had the privilege of personal contact with Sir John, many of them have learned to know him through his journal. They have come to regard him as a highly cultured gentleman, a scientist and teacher. Throughout the 50-year period, there has been constant evidence that Sir John was alert to the necessity of improving veterinary education and in maintaining it at a high level. His labours in research are well known and have thrown much light on many difficult problems. There is probably no other scientist who has achieved so much as Sir John in improving the status of comparative medicine. His standing in the profession is illustrated by the many important positions to which he has been appointed or elected.

The Canadian veterinary profession is happy to add its felicitations to Sir John upon reaching this important milestone in the history of this journal and to wish him continued health and happiness.



INDIA PAYS TRIBUTE

THE following message has been received through Sir Arthur Olver, C.B., C.M.G., F.R.C.V.S., Imperial Council of Agricultural Research, India, in the words of an Indian graduate (Mr. P. G. Malkani, B.SC., M.R.C.V.S.) now serving in India who had been during his studies in England in close personal contact with Sir John M'Fadyean :—

It is with greatest pleasure that I take this opportunity of paying my humble tribute to my teacher, Sir John M'Fadyean. His manifold services to the veterinary profession as teacher, research worker, author and editor are well known to every one. No one who came into contact with him could resist the inclination to follow in his footsteps and if a census of veterinary research workers were taken it may easily be discovered that a great majority of them have had their training under him. To India, the value of Sir John M'Fadyean's work must be reckoned in terms of the large number of workers engaged in teaching and research who had the good fortune of coming under his influence. When one finds that most of the workers of the pioneer institute of Veterinary Research in India at Muktesar: Sheather, Pool, Edwards, Cooper, Ware, have been those who had the closest contact with him and had actually worked as his assistants before they came to India, one cannot but ascribe the achievements of that institute to the indirect influence of Sir John as a teacher. There must no doubt have been many occasions when in addition to the inspiration and instructive guidance available in his writings his students must have resorted to personal consultations with a view to elucidating the different disease problems confronting them in India.

As already said, the writings of Sir John are full of inspiration and instructive guidance. Indeed, the value of his contributions to veterinary literature must be compared with that of the classics. Every worker in the field of pathology in India knows how often he has had to draw at the " fountain head " for guidance in the handling of his particular problems.

The *Journal of Comparative Pathology and Therapeutics* is easily the best of the veterinary journals in the world and it would be no exaggeration to say that the scientific and thereby social uplift of the veterinary profession is in a large measure due to the highly scientific tone of the material presented in this journal. And when by its Jubilee issue we are reminded, that Sir John has edited and kept up the tone of this journal almost single handed for the last fifty years, our admiration for him knows no bounds. As his old Indian pupil, to him I repeat " *Namaste Guru* " (I respect you, my teacher).

A Tribute from Scotland.

By J. RUSSELL GREIG, PH.D., M.R.C.V.S.,
Director, Moredun Institute, Animal Diseases Research Association, Edinburgh.

One may perhaps be forgiven the sin of pridefulness in the thought that Edinburgh has proved a remarkably productive centre of veterinary literature. That it was in this city that the *Journal of Comparative Pathology and Therapeutics* had its birth is not altogether surprising, for apart from other considerations, it was Edinburgh with all her atmosphere of literary tradition that provided the locus for the early labours of the founder of the journal whose aim it surely was to inculcate a spirit of scientific endeavour and to provide a medium for the expression of that spirit.

How magnificently M'Fadyean succeeded cannot properly be told, because it cannot properly be realised. The value of his contributions to science, the influence of his teaching and example, the products of his wisdom in Council—all are incalculable, and for half-a-century he, practically single-handed, maintained his journal on a high plane of scientific and literary excellence.

If to-day the British veterinary profession is at last receiving its rightful place in the Assembly of Science it is only because it has earned that place on its own merits, but it was M'Fadyean, above everyone, who inspired and led us, when we were very young.

J. Russell Greig.

A Message to Sir John M'Fadyean.

From THE ROYAL ARMY VETERINARY CORPS,
Army Veterinary Department, The War Office, London.

All officers, past and present, of the Royal Army Veterinary Corps, are happy and privileged to join in the universal tribute to the outstanding work that Sir John has contributed to the veterinary profession.

A large proportion of the officers in our service received their initial training under his most able and lucid guidance. He set a standard of high scholarship and thoroughness, but what is perhaps of greater value—those who sat at his feet were set a high example of integrity and character which ennobled the profession they had decided to follow.

The Army Veterinary Department owes an inestimable debt to his pioneer work in the diagnosis of glanders with the mallein test which placed in its hands a sure means of controlling this disease in the Great War,

removing this dire menace which in past wars had decimated horses congregated together under field conditions.

Throughout the War his advice was sought by the Army Veterinary Department, and always it was given with graciousness. It gave the Department confidence that what he advised was based on long experience and wide knowledge.

He was one of those investigators who set truth above all things, and nothing was published by him that had not stood his rigid test of veracity.

The Corps is also proud of the world-wide distinction that Sir John has attained—and of the recognition that other countries have paid him.

We extend to him our heartiest and most sincere congratulations on his completing 50 years as Editor of the *Journal of Comparative Pathology and Therapeutics*, and wish him many more years to remain at the head, to guide and grace the profession.

Sir John M'Fadyean's Work on the Council of the Royal College of Veterinary Surgeons.

By LT.-COL. P. J. SIMPSON,
D.S.O., F.R.C.V.S., T.D., J.P.,
President, Royal College of Veterinary Surgeons.

The Jubilee Number of the *Journal of Comparative Pathology and Therapeutics*, which is devoted to an appreciation of the scientific work of its founder and editor, Sir John M'Fadyean, would be incomplete if it did not make mention at the same time of the outstanding services he has rendered to his profession as a member of the Council of the Royal College of Veterinary Surgeons for a period of more than 44 years. In mere length of service Sir John's membership of the Council exceeds all previous records; in its quality it has never been surpassed. In a short note such as this it is impossible to do more than mention briefly some of the more outstanding of his contributions to the advancement of the status of his profession.

He was elected to the Council in 1893, and ever since that date he has attended assiduously all meetings of Council and of the Committees of which he was a member, and no meeting would be felt to be complete without his presence and

without the advantage of his contributions to the debates. He took his duties seriously and no matter of importance ever escaped his attention. His ability to express himself in clear and telling phrase, his deep insight into the needs of the profession and his forceful and sometimes caustic criticisms, made him at once a powerful advocate and a redoubtable opponent.

He was elected a Vice-President in 1897, and in 1906, the year after which he was knighted, he was made President, an office he held with dignity and distinction until 1909. On the death of his successor in office, Mr. Locke, in March, 1910, he was elected to the Chair for the remainder of the period. Again in 1930 he was re-elected President of the College, it being universally agreed to be fitting that the holder of the high office of President of the International Veterinary Congress of that year should at the same time be the official head of the profession.

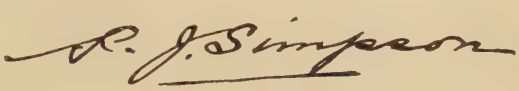
In 1927, the Council of the Royal College elected him an Honorary Associate of the College, a distinction rarely conferred upon a member, and in 1933, he was elected a Fellow of the College under the provisions of the Charter of 1932 which authorises the Council to elect not more than two members in any one year to be Fellows on account of the eminent services they had rendered to veterinary science. Sir John was the first to receive this honour.

From the beginning of his work as a member of Council, Sir John's greatest services were rendered as a member of the Examination and Parliamentary Committees. In the former he was the staunchest advocate for a high standard of general education and, indeed, in 1896, he resigned his membership of the Council and contested an election on the very question of the educational standing to be demanded of intending veterinary students. At the subsequent election he was returned at the head of the poll with the largest number of votes ever recorded. He was always a keen critic of amendments to by-laws regarding the examination syllabus, and his help in moulding the syllabus of the present five years' course was most valuable. He was firm in insisting on the importance of providing means for veterinary students to see practice for at least 6 months before taking their final examination. In all this he was actuated by a consideration of the best interests both of students and of the profession. He was always a friend of the student and a champion of his rights, and many of them, without knowing it, owe him a very deep debt of gratitude for his championship of their cause.

In the Parliamentary Committee, Sir John's wise advice was always of the greatest possible assistance and was always welcome. He was one of the few members of Council who led the profession in the appeal to Parliament for additional funds for the College by the institution of the Annual Fee, and he was Chairman of the Committee which during the strenuous years, 1908 to 1920, worked incessantly, and against constant opposition from without, for the obtaining of the Amending Act of 1920, which for the first time placed the College on a satisfactory financial basis.

Sir John still maintains at 84 years of age a wonderful activity of body and brain, and he rarely misses a meeting of Council. It is, we believe, no secret that he enjoys a round (or even two) of golf almost daily, and although it might be thought by some that he has retired from active work, it is a fact that he still spends a very considerable time in his laboratory at home, and has never ceased to follow with unflagging interest the progress of his favourite subject, pathology, in its widest sense.

May he long be spared to give us the advantage of his ripe wisdom and experience in the guidance of the political as well as the scientific side of the profession, in which we all acknowledge him to be our leader.



A Reminiscent Note.

By FRED BULLOCK, LL.D.,

Secretary and Registrar, Royal College of Veterinary Surgeons.

I first met Sir John M'Fadyean at the beginning of February, 1907, soon after my appointment as Secretary of the Royal College of Veterinary Surgeons. He had not been present at the meeting at which the appointment had been determined, though he was President of the College at the time, his absence being due to an injury to his right arm. As he had been unable to take part in the selection, it was possible he might not approve of the choice made. I, therefore, called upon him on taking up my duties, and found him at 9 o'clock after breakfast in the cosy study of his house at the south-east corner of the old quadrangle. The study led down by three steps to a small conservatory with the garden beyond, which included a tennis lawn, and the tall trees of which only two now remain. His study struck me as being the workshop of a very busy man, and I could not see how the desk could be used or even closed, every inch of it being covered with letters, papers and journals. They covered also two small tables and overflowed to the floor. He was sitting before the fire correcting a galley proof. He disembarrassed a chair for me, piling the papers on to another, and bade me be seated. I do not remember our conversation, but I knew that I had met a gentleman, who would understand the difficulties of a secretary coming new to a strange job. During the remaining period of his Presidency, which to my great satisfaction lasted until July, 1909, I was a frequent visitor at 9 o'clock in the morning before going on to my office. Sometimes I found him in his laboratory and I learned that he was frequently there at 7 o'clock in the morning. He would not keep me long waiting, and I found I could take every problem to him and be sure of receiving wise and unbiased advice. In later years, the study overflowed into the conservatory and many a difficult report or memorandum has been argued out and polished up there.

When the Council decided in 1907 to promote a Bill in Parliament to authorise the payment by members of an annual fee, Sir John M'Fadyean was appointed Chairman of the Committee. That Bill roused up unexpected controversy with the Royal Agricultural Society and especially the Highland and Agricultural Society of Scotland, who interpreted one clause as giving new powers to the College to prosecute unregistered practitioners and as menacing the liberty of stockowners to employ unqualified persons to attend to minor ailments in animals. It was a complete misunderstanding, but to answer their objections it was necessary to obtain opinions from eminent legal authorities, and in this very difficult and delicate business the Chairman's clear understanding of the position, his ability to express his point of view

in the clearest possible manner, and his readiness to interrupt his own work to help me in the drafting of the voluminous correspondence which the controversy entailed, saved me much anxiety and placed me under a debt to him which can never be repaid. This intercourse with him was invaluable experience to a new Secretary and I count myself fortunate to have begun my duties while he was President. It was from him I learned the aims of the Council and became able to apply my own efforts in the right direction. I mean by that the direction in which I could count on the approval of the Council, for it must be remembered that as the Council meets only four times a year it was necessary that many decisions must be taken in the intervals of meetings, and yet nothing must be done of which the Council might disapprove. It was a most precious advantage to be able to consult one who knew the mind of the Council; for in those days Sir John M'Fadyean was already an acknowledged leader of the Council's policy.

Later when he was President of the Organising Committee for the 1914 International Veterinary Congress and the preliminary work had been done by the Honorary Secretary, Sir Stewart Stockman, Sir John asked me to organise the necessary administrative work in preparation for the meetings. This brought us into still closer and more continuous contact. No one in this country knew better than he the veterinary organisations in different parts of the world and it was upon his knowledge that we had to draw in our endeavour to bring to our meeting in London a representative gathering of the most eminent veterinarians from every quarter of the globe. We succeeded in enrolling, in spite of the troubled conditions in Europe, a record number of members. But we were doomed to the bitterest disappointment. The Congress, planned with so much anxiety, had to be abandoned on the day after its opening owing to the outbreak of the Great War. Our Reception at the Natural History Museum was spoilt by the absence of many foreign delegates, some of our own members were already in uniform and one of Sir John's own sons was called up. Sir John had to meet this unprecedented situation and to undertake the responsibility of closing the Congress. This difficult duty he performed with calm dignity but with a clear appreciation of the seriousness of the occurrence. He told me it would be 16 years before a new congress could be organised. His forecast was uncannily exact, but the whole profession is proud and glad to remember that he was able in his 78th year to undertake the double duties of President of the College and President of the Congress in 1930.

He retains in his semi-retirement the respect and esteem of the whole profession and this symposium is the spontaneous expression of the affection in which he is universally held.

*The National Veterinary Medical Association of Great Britain and Ireland :**

A Tribute to Sir John M'Fadyean.

By DONALD CAMPBELL, M.R.C.V.S.,
Rutherglen, President, N.V.M.A.

Veterinary surgeons in every branch of the profession's activities must welcome the opportunity which the publication of this number of the *Journal of Comparative Pathology and Therapeutics* presents, of paying tribute to one of the most illustrious veterinarians of all time, Sir John M'Fadyean.

In the course of things, there can be but few able to look back over the whole of Sir John's long career, but his achievements are a part of our history. Not only are they notable in the annals of the veterinary profession, but they have attracted the attention and commanded the admiration of scientists all over the world, and, in doing so, have brought to veterinary science a credit which is perhaps beyond our power to estimate.

Sir John M'Fadyean does not appear to have been closely connected with the control of the Association for which at present I am privileged to speak, the National Veterinary Medical Association, but he was an active member of the Society which preceded it, the old National

*Until the Annual Meeting held in London, in 1919, following which the N.V.M.A. was reconstituted in its present form, Sir John M'Fadyean had taken, during a period extending over 30 years, a prominent share in its activities and his contributions to the discussions at the Annual Meetings rank as outstanding events in guiding professional opinion at that time. His chief work for the N.V.M.A. is indicated in the following short list of titles :—

Became a Member in 1886.

Offices Held :—

1887. Member of Publication Committee.
1891-2. Member of Council.
1892. Member of Publication Committee.
1894. Vice-President.
1896-7. Vice-President.
1901-2. *President.*
1903. *Elected Life Vice-President.*
1910. Appointed Member of Committee to consider Relation of N.V.M.A. to local Societies.

Papers Read :—

1886. *Edinburgh* (With G. S. Woodhead, M.D., F.R.C.P.). Notes on some of the microparasites of the domesticated animals.

Footnote continued on p. 250.

Veterinary Association, and, indeed, officiated for a term as President of that Association. Most of what I might call his political activities have been devoted to the affairs of the Royal College of Veterinary Surgeons, and there, both as President and as Councilman, his clear mind, vast experience and incisive speech have given his contributions to the debates a quite exceptional value.

Many in the profession have had the direct benefit of Sir John's teaching, either as undergraduates or in his post-graduate classes. That was never my fortune, nor has the nature of my work brought me into contact with him at any time. But neither I, nor any of my generation of veterinary surgeons, however remote from him personally, could ever be considered as outside the sphere of his influence. Without Sir John M'Fadyean, the veterinary profession would not have been quite what it is.

1891. *Doncaster.* Tuberculosis of the domesticated animals.
1893. *Manchester.* The requisite inspection of animals intended for food, prior to and after death, with the most humane modes of slaughter.
1896. *Great Yarmouth.* Swine fever : its nature and suppression.
1902. *London. Presidential Address.*

Discussions :—

1886. *Edinburgh. Remarks.* (*Subject* : " Can experimental pathogenesy be rendered useful in elucidating a definite system of veterinary therapeutics ? ")
1888. *Newcastle. Remarks.* (*Subjects* : " Importance of study of comparative pathology " *and* " Inoculation.")
1891. *Doncaster. Remarks.* (*Subjects* : " Black quarter " *and* " Influenza.")
1894. *London. Remarks.* (*Subject* : " Animal vaccines.")
1895. *Birmingham. Remarks.* (*Subject* : " Inspection of diseased dairy cows.") *Opened discussion.* (*Subject* : " Abortion.")
1896. *Great Yarmouth. Remarks.* (*Subject* : " Bovine tuberculosis.")
1899 *Plymouth. Opened discussion.* (*Subject* : " Tuberculosis and its prevention in cattle.")
1902. *London. Remarks.* (*Subjects* : " Glanders " *and* " Pneumonia in the horse, etiology.")
1903. *Windermere. Opened discussion* : " White scour in calves." *Remarks.* (*Subjects* : " Veterinarian in relation to State and municipal work " *and* " Anthrax in relation to trade.")
1905. *Buxton. Opened discussion.* (*Subject* : " Preventive inoculation and the serum methods.") *Remarks.* (*Subject* : " External parasites of the sheep.")
1907. *Great Yarmouth. Remarks.* (*Subject* : " Parasites of the 4th stomach and intestines of sheep and cattle.") *Opened discussion.* (*Subject* : " Actinomycosis and botriomycosis.")
1910. *London. Remarks.* (*Subject* : " Acute granular vaginitis in cattle and its relation to sterility and abortion.") *Opened discussion.* (*Subject* : " Strangles.")
1919. *London. Remarks.* (On questions of incorporation of the Association and the establishment of a journal.)

VETERINARY RESEARCH CLUB: A MESSAGE.

THE Veterinary Research Club gladly pays its tribute in this Jubilee Number to the achievement of Sir John M'Fadyean in completing the fiftieth volume of the *Journal of Comparative Pathology and Therapeutics*. The series of volumes now finished in which much of his own work is recorded, will remain as a fitting monument to Sir John's success as editor and to the many personal contributions which he has made to the advancement of knowledge in Veterinary Science.

Much has been done by the Veterinary Research Club since its foundation in 1924 in developing friendship and mutual confidence among those engaged in the investigation of animal disease, and the freedom of its discussions has proved a constant stimulus to the work of its members. In the success of its own aims it is conscious of the pioneer work of Sir John M'Fadyean in the same direction, and proud of the fifty years record of the Journal he has so ably edited. Many of its members are his pupils and all regard him as the founder of our present veterinary traditions. The wishes of the Club are sent to him for the long continued success of the Journal

President.

Hon. Secretary.

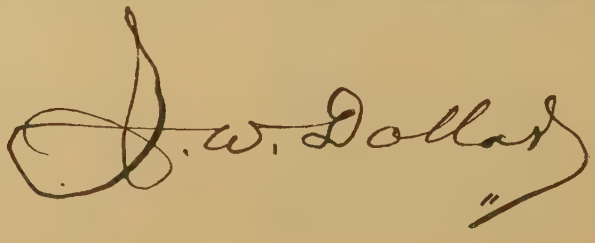
AN EARLY RECOLLECTION.

By J. A. W. DOLLAR, M.R.C.V.S., F.R.S.E.,
President, Royal College of Veterinary Surgeons, 1904-05 ;
Membre de l'Académie vétérinaire de France.

I FIRST knew Sir John when as Professor of Anatomy at the old Dick College some 60 years ago, he was making entire sections of frozen pony carcases for his anatomical work. This was during the severe winters of about 1878-79. One December night of the latter year the tall, old stone house at the corner of Clyde Street, where I then lived, seemed in danger of being blown down ; it was the night of the Tay Bridge disaster. I know all about the so-called students' riot at Edinburgh a year or two later when students with a grievance pelted Fleming with bad eggs and flour in the public streets of Edinburgh and Fleming, who in those days was omnipotent at 10, Red Lion Square, retaliated by suspending several students (including some from the Dick College) off his own bat, and I know the part Professor M'Fadyean (and in some degree I, myself) played in obtaining justice for the wrongfully accused men. Not long afterwards, my deeply loved Principal, Professor Wm. Robertson, died at his desk in the Principal's Office at Camden Town early

in the Summer Session of 1887. At the opening of College next Autumn *not a word* was mentioned of the man who had given his life for the College. His successor's career was not long, its principal feature appeared to be *spending*. It was he, or the Governors, who distributed the little patrimony of the College (houses in Great College Street, where the Research Institute now stands) in useless buildings. Very soon the College was virtually bankrupt. The Governors met, the successor resigned,a new Atlas had to be sought. None of the "old gang" were to be thought of. The Governors did not know where to look. Sir Frederick FitzWygram, who as an "*externe*" student at the Dick Veterinary College about 1849 or 1850 had known my father and never relinquished the friendship, came to consult my father and obtain his advice. By bad luck my father was out. Sir Frederick, who knew I had been a student at Great College Street, and was acquainted with affairs behind the scenes, mentioned the Governors' dilemma and actually asked *me* whom I thought the most likely man. I unhesitatingly said M'Fadyean. I had already a knowledge of his genius as anatomist, his interest as a student, working for the Edinburgh M.B. between his own lectures and demonstrations, his courage in defending his students against unjust action by the Colossus of those days—and I was strongly drawn towards him. "But," said FitzWygram, "he has a very dangerous temper" (this was the reputation given forth by Fleming). I explained the situation to Sir Frederick and he departed—*more suo*, whistling all out of tune and inscrutable. The next thing I knew was when Professor M'Fadyean arrived one evening at our house, 56, New Bond Street, to announce he was to meet the Governors of the R.V.C. the following day over the question of his appointment. The position was anxious, as I assured him, the College nearly bankrupt, its resources nil, the "old gang" bitterly hostile, and the College's reputation with the public at a very low ebb.

Even its own students were against its policy. Professor M'Fadyean came, saw, and accepted. What he has since done is plain to all. For a few years I was Editor of the *Veterinarian*. We agreed to unite it with the *Journal of Comparative Pathology and Therapeutics*, but in very truth my contribution was trifling. Professor M'Fadyean treated me and my small efforts in the most generous way—admitting me to the rights of Co-Editor and colleague. In reality my work was that of reading the foreign journals and making abstracts—even this he often supplemented. Industrious, long-suffering, cheerful, self-denying, with a determination that nothing could daunt and a self-command that nothing could shake, he was an ideal colleague and friend. I enjoyed the privilege of companionship with him for years, was always welcome under his roof and sometimes had to thank him and his gracious spouse, Lady M'Fadyean, for admission to one of their charming Northern holidays. What further can I say? For me to attempt an appreciation of his work would be presumptuous. However highly I appraise it, others much better qualified have already delivered their judgment. I can only record my admiration and attachment. Let it rest at that.



Professor Sir John M'Fadyean: The Man and His Work.

By PROFESSOR SHARE JONES, M.D. (V., H.C.)., D.V.Sc., M.Sc., F.R.C.V.S.,

Director of Veterinary Studies, University of Liverpool, Royal Veterinary College, London, 1896-1904.

That the forthcoming issue of the *Journal of Comparative Pathology and Therapeutics* is its Jubilee Number is an epoch-marking event in the history of veterinary literature. Indeed, it is probable that this claim could be made in relation to British literature generally. Surely it is a monumental achievement to have founded and conducted with such pronounced success a journal of this type which, early in its history, secured for itself a world-wide reputation, and the magnitude of the effort is greatly enhanced when two factors are remembered, namely, that it was the work of one man, by whom it was conducted and solely financed, and that it survived a period in the history of publications generally which imposed upon all concerned in their production probably the greatest strain to which such efforts had ever been subjected. How many fell during this period is all too well known and regretted. But this journal survived.

Just as there has been no division of responsibility and effort involved in this, so can there be no possibility of doubt as to the allocation of credit. It belongs solely to Sir John M'Fadyean.

In the light of these salient facts, no critical analysis of the work is desirable, or even permissible—it stands for itself.

But of the man by whose efforts this has come about, a good deal could be written by anyone who has had the honour of knowing him. That privilege has been mine, for I have known him as one of his pupils, as a subordinate member of his staff, as one of his colleagues on the Council of the profession, as a co-worker in the field of veterinary education, and, above all, if he will pardon my presumption in saying so, as a friend and a man.

When we first met more than 40 years ago, M'Fadyean was in his early prime—energetic and vigorous almost to a fault; he had a manner that was generally regarded as austere, and a personality regarded by many as difficult of approach. These combined to form an essential part of the armamentaria of one to whom was committed the difficult task of conducting the concern at the head of which he was placed—the Royal Veterinary College. If they were not an inherent possession they had to be developed and revealed. Those of us who are in a position to view these matters

from the angle of 1937 can place them in their true perspective. Upon him was imposed the whole of the responsibility, and this he accepted, and for 40 years he served the old institution through periods of stress and trial which most men would not have dared to face. In addition, his own personal department was a model of efficiency. He himself gave the whole course of instruction and conducted those researches the results of which have done so much to enhance the science which we profess.

He brought to our science tone and dignity, and the years to which I refer might well go down to posterity as the M'Fadyean era in our history.

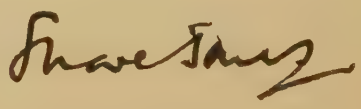
As an anatomist, it is perhaps not for me to say what effect his earlier association with this subject had on him. I know the opinion of such old friends and keen observers as William Hunting. But clarity and logical precision characterised his word—whether spoken or written—and that should be so in anatomy. His contributions to this subject are regarded not only with admiration but actually with affection by many thousands of workers.

A day in his life was so rigidly ordered that a casual observer might be excused for thinking there was no room for anything additional to professional work, prefaced by the morning exercise on horseback taken in the park as regularly as breakfast. Here arises that deeper knowledge which I am proud to possess. Behind all this—so necessary as I have suggested for the discipline, indeed, for the very existence, of the place—was a gentleman of nature. For every attempt at initiative and originality by even the youngest member of the staff there was a word of encouragement. Any sorrow or grief was shared by him to the full. Testimony to this is abundant in my own experience. Reciprocal remembrances were invariably exchanged at Christmas. For many years in our cases they were dually expressed on each side ; then his came alone. But they still come.

These few words constitute but a feeble hint of the one in whose honour this " Volume Jubilaire " is issued. Throughout the history of education in this country, or indeed in any other, it would be difficult to find a parallel to the case of John M'Fadyean by whose singlehanded efforts the Royal Veterinary College, one of the most extraordinary of British Institutions, was kept alive of its own momentum for over a quarter of a century without any form of assistance or sympathy whatsoever from municipality or State.

Material equipment might have been lacking, judged by the much-discussed standards of buildings and apparatus of to-day, but with such a chief there existed what was far greater, a human equipment that made for industry, patience and tenacity of purpose, an example set before us that was an urge to treat difficulties as things to be overcome.

Those of us who survive and belong to his period have cause to feel grateful that M'Fadyean came.



Sir John M'Fadyean:

An Appreciation.

By PROFESSOR G. H. WOOLDRIDGE,

F.R.C.V.S., M.R.I.A.,

Vice-Principal, Royal Veterinary College, London.

I HEARTILY welcome this opportunity of expressing my great appreciation of and indebtedness to Sir John M'Fadyean, though I am fully aware that I can never hope to find words adequate to the occasion. But this is to be rather a personal note, and I will leave it to others to deal with his life work in the realms of veterinary pathology and research. It is of a great teacher and personal friend and colleague that I would speak, and I am proud and highly privileged to claim to have been associated with Sir John in each of these respects.

[*Elliott & Fry.*

It is now more than 40 years ago since I was first ushered into the presence of this great Principal and Dean of the Royal Veterinary College, London. I entered as a boy fresh from the country, nervous and wondering, for the interview, but I came away already encouraged, and I felt I had made a good start on the career of my choice. I was to find out later that this faculty for stimulation and encouragement of the younger men was one of his greatest assets, and the numbers who have been so inspired by him in this wonderful way must be countless.

Great as has been his work in the realms of research, I should be disposed to place his great achievements as a teacher as the greatest of all. It is mainly through this field that his influence is established in all quarters of the globe, and will be longest maintained. He instilled into us all the highest ideals, and his wonderful faculty for clear and lucid exposition can never be surpassed. Though very sympathetic and human, he was a strict disciplinarian and his very presence was enough to maintain order and decorum. Occasional lapses amongst students were inevitable, but justice was dispensed dispassionately and tempered with mercy. I can visualise Sir John smiling quietly at some escapade after he had dealt fairly with it and I wonder if he recalls the occasion when he unexpectedly walked into the old dissecting room and unfortunately intercepted the flight of a " piece of meat " with his beautifully polished topper !

As my Principal and colleague, I was destined to be associated with Sir John for 20 years, and as one met him again at a different angle, one's admiration was more than maintained and reinforced. By force of example, he encouraged his staff in their work without any interference with their respective departments and thus obtained the best possible results and the

absence of any friction. He never spared himself and his colleagues were happy to follow his inspiration.

I cannot adequately express my personal feelings with relation to Sir John, nor can I find words to indicate my deep appreciation of all he has meant to me and so many others during these many years as "guide, philosopher and friend." With his wonderful personality and charm, we are pleased to pay tribute to him as one of our profession's greatest and most kindly gentlemen.

Geo. H. Wooldridge.

A Practitioner's Appreciation.

By S. J. MOTTON, F.R.C.V.S.,

Penzance, Cornwall;

Examiner in Veterinary Medicine and Meat Inspection, R.C.V.S.

During the years 1903 to 1909, while I was a student and, later, a junior member of the staff at the Royal Veterinary College, I wondered often whether anyone outside his family circle really *knew* Sir John M'Fadyean.

He was to me the personification of dignity, a man who appeared to be isolated and who lived only for his work. As students, we knew that he was a scientist with a world-wide reputation, that he was a tremendous force at the Royal College of Veterinary Surgeons, and that he was knighted. This knowledge was, in itself, enough to command respect. But, there was about him something else which was indescribable and which pervaded the College, and this led to good, but not irksome, discipline. Gross breaches were, therefore, rare. He seemed to be always absorbed in some problem, rarely laughed aloud and did not often very visibly smile. But we knew from chance remarks he let fall that he had a very subtle sense of humour. We did not often see in him any sign of anger; he only sighed and did not cease speaking when one day a slaughterman splashed him with fluids from a carcase upon which a *post-mortem* examination was being held. He appeared to have laid out a set course for himself from which he would not be diverted; when a fall from his horse resulted in a fractured arm, it was only allowed to interrupt his time-table for a few hours. As a lecturer, he excited great admiration. Who can have attended his class C lectures or later his long post-graduate course, or the short course on tuberculosis, without being impressed, for ever, by his extraordinary ability to describe things, the depth

of his knowledge, his analytical mind, the caution with which he expressed opinions on matters not yet settled, and his clear and deliberate delivery which made verbatim note-taking easy. In the management of the College, Sir John "ran the show"; he saw to it that the education given was "value for money," and he was *au fait* with all that was going on, whether in respect of the premises or of the hospital.

In common with innumerable other veterinary surgeons, Sir John has meant more to me since qualification than can possibly be estimated. Nor can anyone estimate the actual influence of his teaching in raising the status of the profession, but it has certainly been tremendous. One can only say that his teaching and the early influence of his example must have had far-reaching effects in the attainment of any success that has followed one's efforts. But that is not all. While he was at Camden Town, we were able to send him *post-mortem* specimens and we obtained reports on them free of any charge. We could write to him for his opinion on various subjects and obtain his help. He was almost "unstumpable." We knew there was in him a fountain of information which he would willingly let us tap at any time. Could anyone expect a better post-graduate service? The inspiration of his teaching has overflowed the world like a flood for many years. The real origin of the benefits that have been derived from it cannot always have been realised. I owe him an everlasting debt of gratitude.

Sir John M'Fadyean and Meat Inspection.

By LT.-COL. T. DUNLOP YOUNG,
O.B.E., D.V.S.M., M.R.C.V.S., F.R.S.I.,
Late Chief Inspector, City of London, Smithfield Markets.

Amongst the many benefits derived from Sir John M'Fadyean's labours are the important effects on meat inspection in this country, and in an indirect way on countries from which meat is exported to Great Britain.

It is interesting to note that Sir John and his family connections have been associated with this subject for many years. Professor Walley, his father-in-law, was the first veterinarian to call the attention of members of the profession to their duty to the public by preparing themselves as the persons best qualified to form a correct judgment on the fitness for human food of meat derived from animals slaughtered for that purpose, following the example made by other countries.

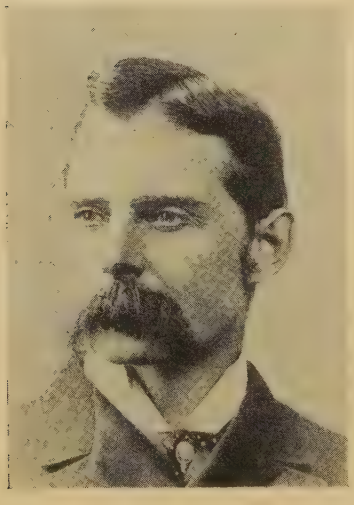
As fully described by Ostertag in his "Handbook on Meat Inspection," veterinarians were first appointed as meat inspectors in Würtemberg in 1761, and later other countries made similar appointments, while Britain lagged behind in adopting such an obvious necessity.

Professor Walley arranged to give his students in their final year a course of meat inspection and eventually induced the Corporation of the City of Edinburgh to appoint veterinary surgeons as meat inspectors; in this progressive work he was assisted by Sir John. Later, Professor Walley published the first book in Britain as a guide to those whose duty it was to inspect meat.

Among the first veterinary students who went forth as missionaries to spread Professor Walley's gospel was the late James King, who began as a meat inspector in Edinburgh, migrated to Manchester, and later transferred to London, where he became teacher on the same subject to students of the Royal Veterinary College whence departed graduates to many other countries to act as meat inspectors. Mr. King was also the originator of meat inspection classes at the Royal Sanitary Institute whence there have passed hundreds of trained lay inspectors. Another well-known member of the profession who was one of Sir John's students is Mr. Trotter, late Chief Inspector, Glasgow, who went from Edinburgh to reorganise the meat inspection department in Glasgow and has taught the subject to hundreds of students at the Glasgow College. Another important member was the late Dr. J. Gilruth, who originated meat inspection in New Zealand, etc.

Sir John was one of the principal witnesses in the famous trial in Glasgow in 1889, when the Corporation obtained a decision in its favour as to unfitness for food of carcases affected with tuberculosis.

Later he acted as a member of the Tuberculosis Commission which drew up recommendations as to what might be considered localised and generalised tuberculosis. These were, for many years, the guide for all meat inspectors. In the meantime, Professor Walley's book on meat inspection had gone out of print, and it was re-issued with Sir John M'Fadyean as editor.



Principal THOMAS WALLEY, 1842-1894.
The pioneer of meat inspection in Great Britain; "a man whose hands and brain worked untiringly for the advancement of his profession, who brought the Dick Veterinary College to the height of its prosperity, and who has left behind him a noble example for his students to follow" (this Journal, 1895, **8**, 91).

No doubt the older members of our profession will remember the occasion when the famous Dr. Koch, discoverer of the tubercle bacillus, came to London, and in an address expressed the opinion that as the bacillus was practically never communicated to man from bovines it was not necessary to make any special examination of carcases affected with tuberculosis. Those who listened to that statement, including the writer, left the hall in a condition of amazement and everyone looked forward to what would be the effect of Koch's judgment.

It was well known that Sir John M'Fadyean was to speak next day and the hall was crowded to overflowing when he rose to speak. His opening words were characteristic of the modesty of the man when he said: "I find myself in the unfortunate position of having to express an opinion contrary to that of one whose

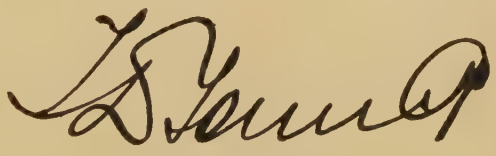
shoes I feel unworthy to unloose, but that will not deter me from expressing my humble objection to the correctness of the opinion he expressed yesterday."

Sir John then gave an address which made every person in the hall feel proud of him. He was followed by other famous speakers, including the late Professor Nocard, with the result that almost immediately a Commission was appointed to investigate and confirm or negative, Koch's opinion.

Later, Dr. Koch, like the gentlemen he was, withdrew his original opinion, with the result that there is now no doubt the bacillus of bovine tuberculosis can, depending on circumstances, cause the disease in man.

Later a younger member of the Walley-M'Fadyean family, Sir S. Stockman, edited another edition of Walley's book on Meat Inspection, and Dr. Edwards, son-in-law of Sir John, has not only taught students, including the writer, pathology and bacteriology in relation to meat inspection for the D.V.S.M., but has also acted as examiner. The writer, trained by Sir John, having re-organised the meat inspection department in the City of London, pointed out the presence of *O. gibsoni*, actino-bacillosis and caseous lymphadenitis in imported meat, with the result that the standard of meat inspection was so raised in this country that Governments in exporting countries had to establish meat inspection departments on a large scale and employ hundreds of veterinary officers.

It is, therefore, not too much to say that whatever progress has been made in meat inspection in this and many other countries, is due first to Professor Walley and later to our revered teacher and friend, Sir John M'Fadyean, who at all times, without reward, freely made diagnosis of specimens sent to him, and thus assisted meat inspectors to carry out their responsible duties so as to safeguard the health of the public with justice to the owners of meat, and one of those who owes to Sir John M'Fadyean a debt he can never repay, is the writer of this article.



SOME SHORTER SPONTANEOUS TRIBUTES TO SIR JOHN M'FADYEAN.

It was late in November last that the notion was conceived to approach Sir John to allot this December issue*—which marks the close of the 50th volume of his journal—to his many contemporaries who, it was felt, would not have wished, had it been brought to their notice, to let the opportunity presented pass by without paying him fitting tribute. Should he consent, it was not anticipated there would be difficulty in preparing, even at short notice, a satisfactory number, for it is on published record that for well over 50 years whenever a movement has been set afoot to do Sir John M'Fadyean honour

* By far the greater part of the material published in this number was received from contributors and set up in print before the middle of January, 1938. There has been some unavoidable delay, it is regretted, subsequently in composing the number. The co-operation of the Publishers in the work of preparation is very much appreciated.

the response of his colleagues, be it said to their lasting credit, has been generous, prompt and unanimous. His consent was obtained, and a free hand given to prepare the issue entirely without his knowledge of its contents according to the anticipated wishes of those who would like to show him respect. Written invitations were sent to those who it was thought could fairly express personal appreciation in short tributes as spokesmen for the many who had come under his influence in various ways and at different times in the course of his long working career, and to those actively engaged in the different phases of work in which he had pioneered who would wish to contribute short records displaying the progress of research, in the form of brief reviews or original articles. Not many days had passed before it was brought home that the invitations were destined to meet with such warmth of approval on all hands that the originally allotted space would be far exceeded. If any comment were sought on the response, it would be that those who had known Sir John longest and had good reason to judge him best and had by their own labours also attained the highest eminence in the scientific world, responded with the greatest alacrity. For example, Professor von Ostertag's and Professor Schmaltz's contributions were received for publication within six days of posting invitations to them. Although the text of this number covers rather more than double the space originally allotted, much more that has been promised has had to be held over. Space has been allotted to a brief survey of only one phase of Sir John's work, *viz.*, on tuberculosis, in this number. It is sincerely hoped that the invitations were sent to those who were best disposed to prepare representative contributions of the variety such as it will be adjudged ought to comprise a *Festschrift* of this kind. Doubtless, however, several contemporaries who have a claim to speak have inadvertently not been reached, and to them an expression of regret is tendered. Any contributions they still care to submit will be received at the Publishers' address and then dealt with, if the Editor's further consent is obtained, so far as is possible in the same way as those which have appeared in the current number. Having been compiled quickly it is believed that the historian may come to look upon the series of contributions in this number as faithful impressionist pictures of an outstanding figure of our time. As stated in the Preface, however, the only calculated design has been to pay a personal, intimate tribute to this outstanding figure. It is readily appreciated that it is not given to all to be able to express readily or adequately their impulses in words written for publication, and those need not be by any means the least sensitive or generous who are unable to do so. For this reason, as probably representing an even truer conspectus of the feelings evoked on this occasion in the minds of Sir John's contemporaries, the following selections from the letters received in reply to invitations are placed on record. Let it be further added at once that in anyone privileged to act as intermediary in the preparation of this number, the day-to-day arrival of such expressions of boundless goodwill towards a leading man who in his time had nothing to offer to the world except the product of his own gifts of character, industry and ability, could not but arouse feelings of the most sincere regard for the men who are either colleagues in the veterinary profession or are associated in some way with it and whose natural impulses prompted them to respond in this way :—

"... I am flattered and I welcome this opportunity. I know the effort is inadequate, but it is sincere and heartfelt, and as such I hope you will accept it."

". . . I deeply appreciate the honour of having an opportunity to contribute to the Jubilee Number which is to commemorate the Grand Old Man of Veterinary Education and Research."

" . . . Although 50 years have passed and I have little remembrance of the place or subject of meeting I can see M'Fadyean now, standing up, tall and thin, stooping forward slightly as he leant on a chair in front of him and speaking very earnestly ! "

" . . . I feel very honoured at being asked to contribute to the Jubilee Number of the *Journal of Comparative Pathology and Therapeutics*, and probably more than most of the profession I feel that anything I have been able to contribute to veterinary effort can be directly ascribed to Sir John's influence."

" . . . I am, of course, delighted to have the opportunity of doing this. It is a very imperfect effort, I admit, but the time is so short and there is so much that ought to be said."

" . . . I am honoured by your request and, needless to say, will have much pleasure in complying with it. My only fear is that I will not be able to do justice to the many grand qualities and ability of our revered teacher."

" . . . I am, of course, extremely flattered at being asked to do something for the Commemoration Number of the *Journal of Comparative Pathology and Therapeutics*, as there is no one in ' our ' profession who holds Sir John in higher regard than I do."

" . . . I shall regard it as a privilege to contribute a very short note on the work and inspiration of Sir John M'Fadyean and will let you have it in the course of a few days."

" . . . I think your suggestion in connection with the Jubilee Number of the *Journal of Comparative Pathology and Therapeutics* is excellent, and I shall have very great pleasure in making a contribution to it."

" . . . I hasten to respond to your appeal. The idea, though belated, is an excellent one and I hope it will give Sir John the satisfaction he so thoroughly merits."—*From East Africa.*

" . . . Very many thanks for your letter and kind invitation to contribute to the Jubilee Number of the journal.
I consider it a great honour to be permitted to do so and I should very much like to submit something worthy of the occasion. But you do not give me much time."—*From Africa.*

" . . . I am honoured by the invitation to contribute to a *Festschrift* number of the *Journal of Comparative Pathology and Therapeutics* to commemorate the work of Sir John, to whom I personally owe my start in laboratory work. It is very good of you to think of writing to me on the subject."—*From Africa.*

" . . . Your idea is, I think, a splendid one and I wish you every success in the preparation of the Jubilee Number."—*From another overseas worker.*

" . . . I trust it will be in time and that it is of the type that suits your purpose, which is a very admirable one and one that we would like to support."—*From Australia.*

" . . . I sincerely commend your intention to issue a Commemoration Number and feel that it will be very much appreciated by all members of the Profession."—*From Australia.*

" . . . I find it quite impossible to prepare an article which would be worthy of this Commemoration Number in the time available. Your letter arrived on the eve of my departure on leave. During these last few days before my departure I have been overwhelmed with other work and duties that I find it quite impossible to write the article. It is with great regret that I have to take this decision because I would have considered it a great honour to be associated with my many other colleagues and friends in paying tribute to the great achievements of Sir John M'Fadyean."—*From Onderstepoort, South Africa.*

". . . There have always been two outstanding teachers in my life, namely the late Sir Arnold Theiler and Sir John M'Fadyean. To both of them I owe a great debt of gratitude and for that reason I am extremely sorry that unforeseen circumstances prevented me from adding a small token of gratitude we owe Sir John M'Fadyean for his work for the good and furtherance of veterinary science.—*From Onderstepoort, South Africa.*

". . . It is a great pleasure to comply with your modest request and I am inclosing a rather brief statement in order that it may reach you in time to serve partly your purpose.—*From America.*

". . . It is certainly a delightful idea to devote a considerable part of the forthcoming number of the journal to commemoration of Sir John's very remarkable achievement as its founder and editor for the past 50 years.

I would certainly be pleased if some little contribution from my pen were included but am a little doubtful whether I can choose a suitable subject and do it justice. Your postscript almost suggests that a very brief review of the liver rot work, in which I had so much encouragement from Sir John, would be appropriate."

". . . You will not require me to tell you how much I approve of the project or how greatly I admire the magnificent achievement of Sir John. It would—under less harassing times—have given me immense pleasure to have consented to your request to write an article for this particular number, indeed, there is little I would not do to associate myself with this laudable object.

. . . Allow me to add my meed of praise for Sir John in his wonderful personal achievement, and thankfulness that he has been spared to carry out this monumental work so well and for so long a time. Without doubt, the *Journal of Comparative Pathology and Therapeutics* not only holds pride of place in this country but in all other countries also, and it must be a source of much gratification to Sir John to know this."

". . . and I feel highly honoured to be thought fit to contribute to what looks like being a very important issue of the *Journal of Comparative Pathology and Therapeutics*. Being essentially a clinician my outlook on veterinary problems is so different from those viewing things from the laboratory and I have always squirmed at the idea of being regarded as a research worker. My incursions into the intricacies of pathology are very amateur efforts, though of intense interest and have been a guiding principle in my teaching of surgery.

I have often gone to the early numbers of the *Journal of Comparative Pathology and Therapeutics* for help and remember vividly the numerous articles contributed by Smith on the various conditions which affect the horse. Walley's articles on Clinical Conditions, and the continued series on Tumours of the Domesticated Animals by M'Fadyean himself were also a sort of Bible to me in my early years.

I wish there were more who would interest themselves primarily in Pathology. . ."

". . . I have a great deal to be thankful for in the instruction I received from Sir John at Camden Town in 1905 whilst attending, probably, the first post-graduate course given at the College, which, like the subsequent ones, Sir John gave without any remuneration from College funds. None of us realised this at the time but it will never be forgotten.

As a student I received no instruction in bacteriology and what I received in pathology was most elementary but after being qualified I seized an opportunity of purchasing a copy of Sir John's notes given at the Royal (Dick) Veterinary College which an enterprising student used to sell at £1 1s. 0d. each. Armed with these and subsequently attending the above-mentioned course I thoroughly enjoyed the research work I was called upon to do on the West Coast of Africa and at the Army Veterinary School. Insignificant as it was, it earned me, on two occasions, letters of thanks from the Army Council and the first brevet-majority ever bestowed on an officer of the Corps. So I have every reason to be most grateful to Sir John for what he taught me."
—*From a Retired Officer of the R.A.V.C.*

I.—THE JOURNAL.

Quoique les nouvelles recherches que j'ai l'honneur de communiquer aujourd'hui à l'Académie laissent encore beaucoup à désirer, telles qu'elles sont néanmoins, elles suggèrent en foule des vues et des tentatives nouvelles. Et puis, comme le dit Lavoisier, "on ne donnerait jamais rien au public si l'on voulait atteindre le bout de la carrière qui se présente successivement et qui paraît s'étendre à mesure qu'on avance pour la parcourir."—Pasteur (1882), announcing to the French Academy the first results of his experiments upon rabies. *Oeuvres*, **6**, 576.

For several years, this journal has appeared as a repository mainly for records of original research in veterinary science. With the multiplication of research institutes devoted to veterinary science in this country, since the State first came to the aid of this pursuit after the provision of subsidy through the Development Fund in 1911, it is likely that henceforward there will be a steadily growing demand on the part of the specialised workers upon the resources of suitable journals for the publication of their work, the papers published representing, as it were, the dividends accruing to the public from the expenditure on research. Nothing need now be added here upon the standard of acceptance of articles for publication in this journal or upon the position it has attained in the scientific and veterinary world; all this is attributable to the private and personal enterprise of its founder and editor* and, in the main, to the standard set by his own numerous contributions. Hitherto, there has been no great overabundance of first-class articles in veterinary science forthcoming to make excessive demands upon the space available in the veterinary periodicals, but hopeful signs are not wanting that the position may before long reach that already attained in other sciences, where most rigid scrutiny has long been exercised in the best periodicals upon authors' texts to prevent encumbering a greatly swollen literature with redundant material. In the case particularly of whole-time specialised research workers the current view seems to be that piecemeal publication of experimental records with the progress of their research is advantageous, so that the results can be made public to other workers engaged in the same field as early as possible, the facilities for confirmation—since the stern lessons of the Great War brought home to the public probably more than anything else the benefits that are likely to accrue, as in no other way, from capital laid out for the prosecution of ordered research—being now so plentiful that there is not much danger of results that are erroneous gaining wide acceptance. The scrutiny that ought constantly to be exercised by directors of institutes and editors upon authors' writings acts to a large extent as an initial safeguard, the main consideration being, as is well known, that the conclusions, precisely stated, should be based on enough observational evidence, reported in most concise form and supported by sound deductive argument, and just enough description of methods for other workers who care to repeat the work to arrive at similar conclusions. The task of editing such articles need not be regarded as having imposed a heavy strain upon the editor of this journal: indeed, if, as is certain, he has met with the same goodwill and spontaneity as has been displayed by the authors who were invited to contribute to this Number, he must have derived for many years

* From 1903 to 1909, the name of Mr. J. A. W. Dollar appears on the covers as co-editor, and from 1910 to 1926, the year of his death, that of Sir Stewart Stockman, but it is well known that the editor took on himself almost the entire work and responsibility for publication.

a degree of interest and pleasure that have far outweighed any expenditure of effort in the preparation of workers' texts for publication.

After close study of the 50 volumes of the journal, each in relation to the circumstances of its time and the resources that were available for the editor to draw upon, it is clear that the task undertaken by him since its foundation far exceeded that which has been implied, and his title to achievement in promoting the development of veterinary science will rest securely on a corpus of literature which must for ever remain evidence of the dominating position that he has held in his own time in his science and that has been freely acknowledged by his contemporaries. Traced back to their beginning, these volumes in which Sir John M'Fadyean has fulfilled the combined role of reporter and editor display a superb craftsmanship in the art of independent self-expression ; this was brought to the service of his vocation stage by stage throughout a critical period in its history, a period —the *grande époque*—when more new knowledge was being added to it than at any previous time and when his powers of scientific observation and deduction, critical faculty, and literary skill directed in this country the flow of this stream of knowledge along a steady course towards the enrichment of the veterinary world and the yield of an abundant harvest the fruits of which are only now beginning to be appreciated. Nothing need now be added in this respect to the tributes already paid.

The editor's position in 1888 when the journal was founded was that of a *veterinary teacher*—then at the Royal (Dick) Veterinary College, Edinburgh —a position which, except for about three months, he occupied throughout his professional career, from 1876, the year of his graduation as a member of the Royal College of Veterinary Surgeons, to 1927, when he retired from the Principalship of the Royal Veterinary College, London. This was a position which, compared with that of the specialised modern research worker provided with the technical facilities of a well-equipped laboratory for the investigation of a set problem, suffered from obvious disadvantages. But it had also many great advantages, and it is to the credit of Sir John M'Fadyean that from the earliest stages of his career he alone among his veterinary contemporaries in this country clearly saw these advantages, and equipped himself by a prodigious effort regardless of immediate personal gain to make the fullest use of them. The details of his biography which would depict fully the magnitude of his effort and such as they are well known to us need not be dwelt upon here. They would more than fill the present Number, and they can be written up again, all to his fullest credit and it is hoped satisfaction and vindication. A short sketch was published as a tribute by the N.V.M.A. in 1936* on the occasion of the Diamond Jubilee of his graduation as a member of the Royal College of Veterinary Surgeons.

All that need be said is that after he had gained an intimate acquaintance with livestock in his youth as a working farmer, and had acquired a sound literary schooling, he entered the Dick College at the ripe age of 21. Realising on appointment as teacher of anatomy at this institution very shortly after completing the two years course of study then required for graduation that veterinary education in Great Britain was very inadequate, he resolved to attend the classes in Science and Medicine at the University of Edinburgh in order to improve his equipment as a teacher. Although he felt obliged to take up medical practice as an additional means

* *Vet. Rec.* (1936.) **48**. 498-504.

of remuneration he found after two years that this work was contrary to his inclinations and could not be made successful as a part-time occupation. During this early period in his career, he realised how greatly the teaching of veterinary anatomy was handicapped by the inadequate character of the text-books then in use, and in particular by the non-existence of any work comparable to those used by medical students in dissecting the human body. The ambition to remove this difficulty was the origin of the text-book he published in 1884, " The Anatomy of the Horse. A Dissection Guide." Although he had always found the teaching of anatomy to be very congenial work his chief interest was gradually transferred to pathology, perhaps in part from a natural bent towards that subject, but probably mainly because of the great attraction to pathological investigation created by the discoveries of Pasteur, Lister, Koch, and others, and the immensely greater importance of the pathology of the domesticated animals from an economic point of view. Soon after he had completed his studies at the University, in 1883, he began to conduct a class of pathology at the Veterinary College. It was mainly a practical class, modelled to a large extent on the instruction then given to medical students in Edinburgh University by Professor Greenfield and Dr. Hamilton, afterwards Professor of Pathology in Aberdeen University. In preparation for this work he acted as one of Professor Greenfield's demonstrators in the University Class for a session. He had now determined to make veterinary pathology his life work, and had for some time been preparing himself in a way that appeared essential, namely, by acquiring the ability to read French and German readily. As soon as the knowledge gained enabled him to extract the sense of the text, he began to read the current continental veterinary journals and text-books—and realised there was plenty of scope for a new British journal mainly devoted to the pathology of the domesticated animals. In the result, *The Journal of Comparative Pathology and Therapeutics* was founded in 1888. Shortly before he embarked on this venture he had commenced writing a comprehensive comparative anatomy of the domesticated animals, only one instalment of which unfortunately had appeared, namely, on osteology and arthrology, before his time was taken up by his new-found life work of pathology. The early training in the teaching and writing upon anatomy, with which was combined at that time that of histology in the Edinburgh school, which then held foremost place as an anatomical school, must be reckoned as a fine preparation for his subsequent career in morbid anatomy and histology. Written over 50 years ago, his two text-books on anatomy still remain the most indispensable text-books in the training of the veterinary student. While text-books are in their nature ephemeral these books are likely to remain for all time irreplaceable for the reason that their author proceeded on a plan that is simple but humanly difficult to follow of describing exactly what he saw, regardless of what others thought they had seen, and as the objects seen are not likely to undergo change it is unlikely that anyone will trouble much to see more than was seen by him or find more apt words to describe what there was to see. This was the simple but consistent system which he came to adopt in his work on pathological anatomy and histology, a field which broadened out to give full scope for his reasoning faculties, and for his gifts of invective in assailing all that did not conform to his inflexible standards, in especial the " theories " of the monarchs in the veterinary world who were styled " practical men " in his time.

It has to be remembered that the course in pathology commenced by M'Fadyean at the Dick College was undertaken on his own initiative and

without remuneration some years before the subject of pathology and bacteriology was included as a separate subject for examination in the syllabus of the Royal College of Veterinary Surgeons. This did occur till 1895 when the course was extended to four years.

In many ways, the beginning of the Journal was therefore imitative. It resulted, firstly, from the training received at the Medical faculty of the University of Edinburgh, and subsequent close association with the younger school of pathologists there who met at the Pathological Club and were destined to occupy later high positions in the pathological world. Notable among these, was G. Sims Woodhead, a few years junior to John M'Fadyean in age who occu ed the post of Superintendent of the Royal College of Physicians Laboratory, Edinburgh, and who collaborated with him in some important papers on animal disease—including bovine tuberculosis and epizootic abortion—published at that time. Later, Woodhead founded, in 1892, the *Journal of Pathology and Bacteriology*, as the result of the transactions of the Edinburgh Pathological Club.

Secondly, material and inspiration was derived from the activities in the well-equipped State-supported continental veterinary schools, which were at that time staffed by a number of brilliant teachers and investigators. Both by study of their literature and visits to their laboratories John M'Fadyean was the only representative of his profession to transfer successfully to English soil the rapid growths of the *grande époque*. We understand that as model for his veterinary writings he took Professor Nocard, of the Alfort Veterinary School, the disciple of Pasteur, and for laboratory research he retained a lasting impression of the distinction of Professor Johne of Dresden. His style of writing had been modelled it seems on that of the 18th century prose writers, his recommendations to his own junior colleagues later indicating that he looked to Addison as his model.

All this training and experience had to be found out of his salary as lecturer on anatomy, which we gather from a remark published in the first number of his journal (p. 89) did not exceed, till he accepted the appointment offered to him at the London College in 1892, £200 a year—a sum which is about one-half that offered now to recently qualified veterinarians who seem as if they need to be cajoled to take up easy whole-time appointments in veterinary research.

The resources of the small College in which he was employed for anything in the nature of experimental research were so meagre that the culture media—the "jellies" as she called them—were prepared at that time by Mrs. M'Fadyean in her domestic kitchen. However, in other respects they were unique for a pioneer. The clinique of the college provided him with a variety of *post-mortem* material, and he was in touch by correspondence with an extremely fertile hinterland in the shape of veterinary practitioners, many of the younger of whom were his trained students, whose interest was aroused to send him morbid material for examination. Prompt and business-like methods of dealing with these sources of supply ensured him an abundance of virgin pathological subjects for study. In the earlier numbers of the journal notices were inserted inviting practitioners to forward to him specimens of the particular materials—such as the animal cancers—which he wished specially to study. His acceptance of the London appointment in 1892 was, we understood, conditioned mainly by the greatly increased opportunities for practice, and in this we learn he was not disappointed, for during the next 20 years, he has declared, he *post-mortemed* himself every horse that died in the College.

Happily, the setting of the early history of the journal in relation to the circumstances of its time has been precisely summarised recently in his masterly book—*Histoire de la Médecine Vétérinaire*—by Sir John M'Fadyean's friend and close contemporary Professor E. Leclainche, himself a close observer and participant in the events of the *grande époque*, and we feel we cannot do better in displaying this setting than reproduce in translation the short sections of his book which treat of this period.

The first volume of the journal opens characteristically. No indication is given of the scope of the journal or of the aspirations of the editor. These are reserved for a short editorial article which appears at the end of the fourth number. Instead, as if the mode of opening had long been in his mind—having regard to the choice of subject, the journal opens with a technical article by himself—The Pathology of Hæmoglobinuria (Azoturia) of Horses. There, in introducing this subject he finds fitting opportunity to state almost his whole creed and mission on the first page and at once sets about to fulfil it. "One of the most practical veterinary surgeons existing"* as Professor Williams was referred to in a contemporary periodical, had emitted a "theory," which was that this disease was caused by an excess of urea in the urine, and, hence the name, Azoturia, he had given to it. " The pathology of the disease is, in my opinion, a hypernitrogenous condition of the blood and system generally, due to over-feeding and want of exercise ; the excessive secretion of urine and excretion of urea being physiological results due to the presence of effete products, metamorphoses of nitrogenous food in the blood." It may seem flippant to reproduce this kind of statement at this present time, were it not that we are persuaded that nothing else can so well represent what we find to be entirely typical of the veterinary writings of those who commanded respect in the British veterinary world at the time when M'Fadyean opened his journal. An eminent literary critic has recently written about a new science now much invoked by the credulous : " Psychology is, in fact, usually a mixture of four ingredients in varying proportions—sound scientific observation and deduction, common-sense, personal opinions disguised in technical language, and mumbo-jumbo, the whole liberally seasoned with a sprinkling of pure platitude." We need not pause to consider how M'Fadyean dealt with Professor Williams' theory, and in all succeeding numbers of his journal consistently when it was worth while in the interests of his science with similar theories, except to say that he first of any in his profession used all his gifts to exclude all but the first two of the above ingredients, with a kind of impersonal indifference as to the resentment provoked in the person in the process of shattering the person's loose opinions.

In the editorial article at the end of the first volume, we learn that it was the editor's intention to allow the scope of the work to which he had set himself to be unfolded by the contents of this volume, feeling assured there was a void in the current literature of the Science of Medicine (using the word in its widest sense) which his venture would in part fill up. " What may be called veterinary pathology is at the present time in a very crude state as compared with the pathology of man, and we wish to gather into our columns everything that will help to place it in a more advanced position. The success of our efforts in this direction will depend mainly upon the manner in which they are seconded by our readers. We often think with great regret of the immense amount of valuable pathological material that

* *Veterinarian* (1890), **63**, 112.

in everyday practice is allowed to pass unutilised, in the sense that it is imperfectly investigated and not at all recorded." Almost alone and single-handed in his profession in this country he laboured for over a generation to remove this reproach, until his calling had become strengthened by enough scientific truth to gain a position of self-respect. This was when, in the words he used later, it had learned to " stand on its own legs."

The earlier volumes, down to about the year 1904, *i.e.*, about the first 17, have a very different aspect from later ones. It is possible to gain from these earlier volumes a general *aperçu* of the progress of the whole field of veterinary science, and the part played by the editor himself in directing this progress. They contain regularly general articles, editorial articles, reviews, clinical articles, abstracts, and reports of society meetings. They are in no wise, however, in the nature of bulletins, in which a précis is made of the publications of the period. Among the general articles there are full-length translations of the most important continental papers of the time ; the first number contains a translation of such an article, on the diagnosis of glanders, by Nocard. The abstracts were also usually reproductions of important papers, without excision of essential evidence or argument. Some of the more important papers in the British medical literature are also reproduced. It is interesting as showing the problems which were paramount at the time in veterinary pathology now to read a lengthy general article in the first volume by Sims Woodhead on the morbid anatomy and histology of pleuro-pneumonia. The editorial articles which ran to about four in each number in the earliest volumes touched upon nearly all the most pressing problems of the time in veterinary science, and are in themselves perhaps the most valuable additions ever made to British veterinary critical literature. Hardly anything in them has not withstood the passing of time, and with the immense additions made to veterinary knowledge by the discoveries of the period they exercised a salutary effect in resolutely directing veterinary endeavour in this country to apply them in straightforward and effective ways and away from dangerous and illusory courses. Although the contribution made to the advancement of knowledge upon grave problems in animal disease, such as glanders and tuberculosis, may have been much greater in some other countries than in Britain, in no country has the veterinarian been so clearly informed upon the methods that are practicable and likely to be effective in solving these problems.

With the great expansion in veterinary pathological science from the beginnings, as represented at any rate in this country, at the date of the foundation of the journal it is evident that a change would have to take place in the context of a journal that was the part-time occupation of one man. In 1892, he was offered and accepted the Chair of Comparative Pathology, founded at the Royal Veterinary College, London, with the aid of a grant (£500 yearly) from the Royal Agricultural Society of England begun in 1889. He was given the title of Dean temporarily until the retirement of Sir George Brown from the Principalship two years later. His courses in pathology at the Edinburgh school were continued and developed by his disciple Stewart Stockman until 1900. The teaching of pathology was then commenced in earnest at the London school and developed in his day until in 1921 it was stated in evidence before the Advisory Committee on Research into Diseases in Animals appointed by the Development Commission that a higher standard had been reached in this subject than at the medical schools. Furthermore, with the rapid and alluring advances made in tropical veterinary pathology, in which he took a great interest, special post-graduate courses of instruction

especially in this subject were commenced by him in 1903, and these courses, each of two months duration, were given by him soon twice yearly until the outbreak of the War in 1914. Special mention must be made of the help given to him in bearing this strain by his chief assistant, A. Leslie Sheather, who served as his demonstrator from 1906 onwards. With the appointment of Stockman as Chief Veterinary Officer of the Board (now the Ministry) of Agriculture, there ensued a close collaboration in the prosecution of official researches and control measures—into epizootic abortion, swine fever, pioneer legislation upon tuberculosis, foot-and-mouth disease, etc. It is therefore also evident that after the year 1903 the spare time at his disposal for the journal must have been much restricted. By then, however, the course of progress in veterinary science had been largely set, and the vigorous writing of former years was no longer so essential. When at last, the State came to the aid of veterinary research in 1911, and the pathological laboratory at the London school came to be designated a research institute, it seemed for a time that the flow of records upon large-scale experimental research from this institute would nearly monopolise the space in the journal. However the cataclysm of the Great War supervened, the young assistants whom he had been able to employ at last for more intimate training all joined up, and there is no need to dwell upon the manner in which an auspicious promise in veterinary research under a great master then in his full powers suffered, as it did in all other branches of agricultural research, as is evident from the Annual Reports of the Development Commissioners, from this disturbance.

Thanks largely to the great store of materials that awaited examination by the Editor in the histo-pathological field, the journal was able to weather the stress of the Great War. It is a pity that opportunities were not given him for a more exhaustive recording of his collected specimens, but since his delayed retirement, in 1927, a number of valuable papers in this field have been published. At last, it seems, the number of workers engaged in veterinary research and the spirit of enterprise and good fellowship that animates them will ensure for always an abundance of original material for publication in a journal of this kind.

II.—THE MAN.

C'est donc une fausse louange qu'on donne à un homme quand on dit de lui, lorsqu'il entre, qu'il est fort habile en poésie; et, c'est une mauvaise marque, quand on n'a pas recours à un homme quand il s'agit de juger de quelques vers.

Il faut qu'on n'en puisse dire, ni: "Il est mathématicien," ni "prédicateur," ni "éloquent," mais "il est honnête homme." Cette qualité universelle me plaît seule. Quand en voyant un homme on se souvient de son livre, c'est mauvais signe . . . ."—Pascal. *Pensées.* (34, 35.)

Impressive as have been his published writings, a sincere and widespread desire has been expressed on this occasion to pay tribute to Sir John M'Fadyean for the personal influence which he has wielded in his time in shaping in other ways the destinies of his profession, and to place on record the measure of his influence and legend. Except that with the fuller details of his life and work spread out mentally before us now, a duty lies to single out the most conspicuous services he has rendered which place us under the obligation of expressing gratitude to him, nothing need be added to the generous language in which his contemporaries have on fitting occasions

already left on record their good opinions and to which may now be annexed the faithful tributes of those who were invited to contribute to this Number. Among older men, who have had opportunities of contact with him, in his early prime, including those in whom one would think there would have lingered resentment from the chastisement suffered from his outspoken criticism of their views, there is witnessed a tacit deference to his personal qualities as a great leader among them which in the minds of the younger men in his calling survives as a powerful " legend." If we ask in what precisely this legend consists, we may approach a livelier understanding, not of him only, but of his profession as it was when he came into it and as it is now. Something has been said already in the above note we have written upon the history of his journal which would help towards this understanding. He will, we are sure, accept it as an honest tribute when we say, that he was never a " popular " figure of his profession in the sense that he appealed in any way to the sentiment and emotion of the general public rather than purely to the reasoned judgment of men who were endowed with an educated intelligence in whatever community—veterinary, agricultural, medical, scientific, or governmental—that stood to gain from such truthful statement as was uniquely in his power to give them and was called for. Much has been said, and with justice, about his power to raise the social status of his profession, although that service is perhaps more questionable than it appears to be, for the coming together of the veterinary clinic, *post-mortem* room or laboratory and the drawing room is not an unmixed advantage to either. Although during a long life he has no doubt exercised more influence in the councils of his profession as a corporate body than any other member in his time, it would, we are sure, be wrong to pay tribute to him for political sagacity, were this attribute to imply that he has counselled any course of action to achieve recognition that subtly deviates from the direct one which in all his utterances he has urged his contemporaries to follow with single-minded consistency, which is " to strive after that increase of knowledge with regard to animals' diseases, which is *the only way* by which we can increase the value of the services that we are prepared to render to the public."*

We may now ask at what stage in his career were his qualities brought to bear with most decisive effect upon the progress of the veterinary profession and of veterinary science. A few years ago, a Royal Commission appointed to enquire among other things into matters of veterinary research† reported that they had been much impressed by the evidence given by the director of one of the foremost research institutes in this country that " few men are able to evolve new ideas after the age of 45 or to adapt themselves to new conceptions in science after the age of 50." The Commission agreed as to the advantages of youth in all forms of pioneer work, and further strongly deprecated the idea that the directorship of a research institute should be the reward of seniority in service. This view has been much contested, and the careers of eminent scientists such as Pavlov would tend to show that some of their best work may be produced at a much later age. The career of Sir John M'Fadyean would also seem to bear out strikingly this contestation, for even now at his present age it would not be surprising if there will yet come from him his " Testament of Beauty." Paradoxically, however, if

---

* *Vet. Rec.* (1906.) Jan. 13. 487.

† Royal Commission on Agriculture in India, Report, 1928. p. 316. (Calcutta.)

we exclude what may be regarded merely as the products of his settled qualities and fix our mind upon any larger events in the development of his vocation that may have taken a decisive turn from the impact of the full vigour of his personality, we find that the view expressed by the eminent witness before the above Commission is entirely corroborated. Very little evidence of the unfolding of events in veterinary education or investigation is to be obtained from the official reports of the teaching institutions with which Sir John M'Fadyean has been associated. The circumstances of their unfolding survives mainly in the memory of an older generation of men who witnessed them, but their report is amply corroborated by reference to passages in the contemporary literature. Thus, in the year 1890 (April 1, p. 211), we find in *The Veterinarian*, a long-established periodical then edited by the senior members of the staff of the Royal Veterinary College, London, an editorial article, headed, " Investigation and Instruction," which runs as follows :—

" With the aid of a liberal grant [£500 yearly] from the Royal Agricultural Society, a new department is about to be opened for the systematic investigation of diseases of farm stock; and we may state that arrangements are so far advanced that the College authorities are prepared to receive applications from candidates for the office, which for the moment we may designate by the title of Professorship of Bacteriology and Comparative Pathology.

" Tentatively, the above title describes the kind of candidate required, *i.e.*, a bacteriologist of experience, familiar with all the methods of cultivation and preparation of microbes and morbid structures. Nationality need not be a consideration if the word be taken to include familiarity with the English tongue.

" Knowledge of the science of pathology is quite indispensable; but practical acquaintance with diseases of the lower animals need not be insisted on, as the veterinary staff at the College can supply that omission. The chief work of the new officers will be, as we understand, that of taking up the inquiry at the point where the practical man leaves it . . ."

Small though it may seem to be in comparison with the sums that are now allotted for research into animal diseases, this grant from the R.A.S.E. may be looked upon as having provided the means of opening up the study of veterinary science in this country. For this reason, special prominence is given in this number to the tribute from this body. The immediate effect this grant had upon the authorities of the College was that it provided " the first impulse " (*Veterinarian*, 1890, July, p. 429) for an expensive outlay on a new range of *buildings*. Enough has been said in the preceding section to indicate what could be expected of the " practical men " of the time if inquiry was to be taken up only after the subject of inquiry had left their hands. It is in truth on record that the College at that time was in their hands a " bear garden."* We need not dwell longer, as a close witness of the events has already dealt with it in one of the tributes, upon the state of affairs that prevailed in this institution, except to say that it is fortunate for the whole history of British veterinary education and veterinary science that before the end of the following year, 1891 (December 18th), the Governors turned their minds from buildings to a *man*. The only man was invited and accepted who could have saved for the British veterinary profession whatever content of self-respect it was to become entitled to hold as an educated scientific body in the public esteem and in the eyes of the veterinary professions of other countries. We are well assured that at the moment of his appointment no one differently endowed or equipped could have saved it. His appointment was, we are told, due to the personal influence of no

* *Vet. Rec.* (1928), **8**, 587.

one, but he succeeded because he stood head and shoulders above any man in his profession at the time and was of such outstanding ability that no veterinary college could have conferred distinction on him, but quite the opposite. Within a single session, the college over which he presided became an orderly teaching institution. How this was quietly achieved could be related by a few anecdotes, which need not now be recounted. And then, at any rate until its slender resources were strained by the Great War, the personal influence of "the Dean"—it would have been a freedom among the students to have referred to him even among themselves as anything else—pervaded this institution, which became redolent with an atmosphere of authority and prestige such as it had never known, and farther afield this influence was spread from this place of vantage in a way that has been, we sincerely hope, now well attested to him by writers in this number. At that critical and dangerous moment in the history of British veterinary science when he came to its rescue he was 38. Of his natural endowments, nothing further need be said. Of his equipment, which was acquired by his own unremitting effort and initiative and by methods far ahead of his time and which made him in reality the only man in his profession who was genuinely practical at his task and not isolated in its accomplishment from contact with everybody who mattered in the world at that supreme moment in our history—we cannot be too ungrudging in the expression of our respect and admiration.

III.—SIR JOHN M'FADYEAN'S DISCIPLES.

It has been well said that a teacher whose disciples do not go beyond him has failed.—Sir W. Langdon-Brown (1938). *Lancet*, i, 277.

From what has now been said, it will be understood that Sir John M'Fadyean had to rely as a pioneer in his line of work upon his own industry and ability for its almost complete execution especially during the early and middle stages of his career, and it was not until rather late that the financial resources of the institutions in which he was employed permitted him to obtain qualified men specially appointed as his assistants. To some younger men who worked under him during the later stages of his active career, it often seemed at first for this reason that he did not possess the faculty of delegating work and responsibility in the manner which is now largely customary in research departments organised for the prosecution of what is called "team-work." The smallest details of observation upon the matters that were the subject of enquiry did not escape his own scrutiny, and he undertook himself the necessary reporting or teaching persistently as if he were somehow conscious that the most highly trained powers of observation and reasoning and expository faculties soon begin to wane for want of exercise when allowed to become idle. Afterwards, however, the same men have been inclined to look back upon their experience of his methods of self-reliance and infinite care in ensuring accuracy through personal attention as an invaluable training. No one probably wasted less of his working day than he did, appeared less hurried or worried, or planned it with such meticulous regard for punctuality and prompt dispatch of the large variety of business which each day eventually brought to him for disposal. No calls upon his time, whether for advisory, committee, or other outside work were deemed to warrant neglect of his duties as prime observer and teacher in his own line of work. So-called

administration and committee work, which now too often seem to provide a sufficient pretext for the neglect of these more exacting duties, were carried out thoroughly and swiftly, so that the College secretary, for example, regularly early each day was presented in a few minutes and with surprising ease with all the solutions needed to the more difficult problems of that day. This degree of almost superhuman concentration on his work was, we are assured, particularly evident during the earlier stages of his career, and upon the mind of his chief disciple, Stewart Stockman, the memory of those early years in Edinburgh left a deep and abiding impression. Mettam, who succeeded in the teaching of anatomy, and was later Principal of the Veterinary College of Ireland, was also a distinguished disciple of those days.

After his appointment to the London College in 1892, it was not until the year 1903, when he started his post-graduate courses that the College authorities sanctioned a demonstrator. It is a debatable question whether in the daily intercourse of the laboratory it is possible for a man of 50 or over ordinarily to communicate the workings of his mind readily to the recent graduate, of about 21 or 22 years of age, except when an intermediary —comparable to the " senior subaltern " in the army—serves to interpret the older man's tradition. This may account for the pre-eminence of Stockman as a follower of Sir John M'Fadyean. The younger men whom in later years he had formed the habit of calling " his assistants " were the members of the junior clinical staff (hospital surgeon and tutor), and they gave him invaluable help when they could be spared from their other duties in carrying out observations upon animals under experiment. He has given public utterance to the remarkable assistance he received in this way from Hobday and Male, and later he has mentioned Motton. He has expressed the view that it is noteworthy that these men who distinguished themselves as his assistants were destined to succeed to eminence later as private practitioners. The first demonstrator appointed, in 1903, was the late Sydney Dodd, who held the appointment for two years and later achieved distinction as a teacher and investigator in Australia. He was followed for a year by W. T. Collins, who now serves in New Zealand. Then in 1906, A. Leslie Sheather succeeded and remained with Sir John, except for four years in India (1916-20) until the date of his retirement in 1927. The chief reason for writing this short section is to express the appreciation which they deserve, in any form of tribute to Sir John M'Fadyean, of the two men Stockman and Sheather, whose qualities we believe were, in different ways, complementary to his own and enabled him to express himself, as he would not otherwise have been able, to abundant purpose at the fulness of his powers. What Stockman achieved at the Ministry of Agriculture, after his appointment as Chief Veterinary Officer in 1905, Sir John has himself expressed in a short obituary notice written in this journal (1926, **39**, 164): " His success at the Ministry was due to the fact that he combined with a knowledge of the contagious diseases of animals that was both wide and deep a quite exceptional ability for organising and administration and a rare gift of inspiring in those with whom he was brought into contact, from Ministers of Agriculture downwards, a complete confidence in his uprightness, knowledge, and judgment." What might be added with justice was that his success was due certainly to all these qualities and also to the inspiration and guidance which he had the wisdom to seek constantly from his mentor. The help which was given by Sheather deserves still more pertinent recognition in this number, because it is not generally so well known. By the year 1906, the calls on Sir John M'Fadyean's services had increased so much especially since he had added

to his other teaching duties, the giving of two post-graduate courses, each of two months' duration yearly, and advisory, diagnostic, and research work had also expanded—that it seemed almost inevitable his exceptional physical stamina would not bear the strain he was imposing upon it. For those post-graduate courses, the provision of material for practical instruction was remarkable for a London laboratory, including, as it did, demonstration of most of the animal strains of living trypanosomes, some of the bovine and canine piroplasms, and horse-sickness, besides the usual bacteriological materials. In 1913 again, short courses specially designed to meet the requirements of the newly-introduced tuberculosis legislation were begun. In all this work, demanding much skill in preparation and technical ingenuity probably no man was ever served with more unquestioning fidelity than Sir John M'Fadyean was by Sheather. From 1911 onwards, when the State did come to the assistance of research, the number of assistants steadily increased. There is no need to occupy more space in recounting these recent developments, or in giving even the names of all these younger men. All of them would merely wish, we are certain, to subscribe to an expression of the privilege they still feel in having had the honour of working under a distinguished master and of the debt they owe to him.

Mr. A. Leslie Sheather, D.Sc., M.R.C.V.S.

Born 1883. Appointed Demonstrator in Pathology in 1906, and Senior Research Assistant, 1911, to Sir John M'Fadyean. Director, Imperial Bateriological Laboratory, Muktesar, India, 1916-20. Again, as Assistant Director, Research Institute in Animal Pathology, worked with Sir John from 1920 to 1927.

IV.—SIR JOHN M'FADYEAN AS A SPEAKER IN COUNCIL AND DEBATE.

To those who have come into close contact with him, Sir John M'Fadyean's skill in the use of the spoken word, whether in the classroom, council room, witness box or in his laboratory, has become traditional. Uttered with rigid economy, perfect grammatical phrasing, and inexorable logic, while he himself maintains complete self-command and shows no sign whatever of emotion, his very slightly modulated, soft, rather high-pitched and clear-toned speech with its cultured Scottish accent has been heard times out of number—and in debate it is usually heard last—to provide the obvious solution, to the astonishment of his hearers, to what threatened to become interminable and embarrassing discussion, or to render dumbfounded a somewhat vainglorious or hectoring talker. His utterances were so turned that they would hardly ever need editing to appear worthily

in print. The large gathering at the 11th International Veterinary Congress held in London, in 1930, were provided with a characteristic exhibition of his skill at the opening of the plenary session in which the subject of foot-and-mouth disease was under discussion. As his remarks at that time and the atmosphere prevailing during the incident will be recalled by many readers (it has been already referred to by Professor von Ostertag), the published record of it (translated from the original where the speakers spoke other than English) is reproduced below :—

GENERAL MEETING NO. 1.

TUESDAY, AUGUST 5TH, 1930, AT 10 A.M.

President :
Professor Dr. E. LECLAINCHE.

Foot-and-Mouth Disease.

Reporters : Dr. W. H. ANDREWS, Professor J. LIGNIÈRES, Professor Dr. O. WALDMANN.

The President called upon the reporters to present their reports.

Professor J. LIGNIÈRES (Argentine Republic) briefly summarised his report. At the conclusion of his remarks, referring to the new method of vaccination against foot-and-mouth disease which he had devised, he proposed the following resolution :—

" That an International Commission composed of specialists and clinicians be appointed whose duty it shall be to draw up a programme of tests to which the new vaccine shall be submitted and to suggest means whereby this programme shall be put into operation as speedily as possible."

The PRESIDENT : According to Article 39 of the regulations, this proposal will be placed before the Permanent Commission which will communicate its decision upon it to the Congress at the closing session.

Professor LIGNIÈRES : In view of the importance of the question I request that the following resolution be submitted to the vote of the Congress. I would like to say that this resolution would attain the same result as the President's proposal :—

" This Congress accedes to the request made in Professor Lignières' report with regard to testing his new vaccine against foot-and-mouth disease and recommends to the Permanent Committee its prompt fulfilment."

THE PRESIDENT OF THE CONGRESS (Sir John M'Fadyean) : It is true, I think, that according to the regulations, Professor Lignières is entitled to have this resolution, of which he has given notice, put to the meeting. In the event of the decision of the meeting being one of disapproval of the resolution the matter drops, but in the event of the meeting approving the proposal to constitute a special commission to investigate this method of dealing with foot-and-mouth disease, the matter will still have to be considered by the Permanent Committee, and the result of its consideration by the Permanent Committee will be communicated to the final session of this Congress.

If this proposal is to be put to the meeting for approval, I think it is very desirable that the conditions proposed should be carefully examined. A point which is of some importance is that the method which is to be put into practice on an experimental scale to immunise animals is to be of an unrevealed character until the report of the special committee is received. In short, it is a proposal to recommend the trial of what we would call a secret remedy. I do not say there may not be circumstances in which it would be advisable to accept an offer of this kind, but at any rate in this country we have some prejudice against taking any trouble with an alleged remedy when the details of the method are not disclosed.

I think such a special committee as is proposed is not advisable and is hardly practicable, and at the same time I would point out that what is required here is not an experiment on a small scale with guinea-pigs or any other animal than one of the domesticated species, and that in particular the test must finally be made on cattle, and will have to be on a very large scale to command confidence in the results. In my opinion, anyone who has found a remedy in the sense of an effective vaccine against foot-and-mouth disease will have no trouble in proving that he has done so, and there is no group of countries in which the necessary experiments can be better carried out than in the countries of South America. (Applause.) I suggest, therefore, that Professor Lignières should start by exterminating foot-and-mouth disease in the Argentine or any one of the other South American countries, and thus demonstrate to the world that he has got an effective preventative. (Applause.)

Discussion of Professor Lignières' Resolution.

The Chairman: You have heard what Sir John M'Fadyean has said concerning the procedure to be followed with regard to the proposal submitted by Professor Lignières. The subject is now open for discussion.

Professor Lignières: I am grieved to think that my discovery of a vaccine against foot-and-mouth disease has been viewed in the light of a secret remedy because I have not given its exact composition.

I would like to say that I have undertaken, with the approval of the Government I have the honour to represent here, to disclose the formula of my vaccine as soon as the International Commission appointed to investigate it has acknowledged its efficacy. Besides, in my report, I have made known the characteristics of my vaccine. Moreover, the method of preparing the sera recommended has never been revealed to us.

But, gentlemen, there are other matters to think of, which I state in my report as follows: "I could have, as was at first my intention, made known what this vaccine was, but it would then have been received more or less on trust—as is quite natural, bearing in mind how commonly vaccines have been advertised almost everywhere. The outcome would be very great delay in testing the vaccine, and also probably interminable and futile discussions would take place."

To combat foot-and-mouth disease it is essential to unite all efforts. I believe that after a competent commission, such as I have requested to be set up, has passed favourable judgment and my method has been disclosed, it would find immediate and simultaneous application in all countries, with the result that after a short interval, the few difficulties always associated with the use of a new vaccine in practice would be overcome. In this way by adopting sanitary police measures, which are always essential, in conjunction with immunisation, it would be possible to gain everywhere the upper hand over foot-and-mouth disease.

State Councillor Professor Dr. F. von Hutyra (Budapest): It is outside the competence of the Permanent Commission of the International Veterinary Congresses to appoint a commission to investigate curative or preventive agents and to conduct the relevant experiments to test their efficacy. In this case, the procedure is all the more inadmissible because Professor Lignières has not communicated either the nature, origin or composition of his vaccine and has not stated whether he has carried out any preventive or curative experiments with it. In this connection it may be pointed out that the *Office international des Epizooties* has, among other things, issued a warning against the employment of secret remedies and likewise has arrived at the view that to all appearances a beneficial effect can only be expected from the use of agents containing the virus of foot-and-mouth disease in some kind of form. It is, however, not known whether or not Professor Lignières' agent satisfies even these preliminary considerations.

The Chairman: Does any other member wish to enter into the discussion? Nobody! Then I put the resolution proposed by Professor Lignières to the vote. If the Congress passes it, the resolution will be referred to the Permanent Commission according to Article 39 of the regulations.

The Chairman then read the resolution again and put it to the vote.

On a vote being taken by a show of hands, the resolution was *lost* by a large majority.

[One effect upon Professor Lignières, it may be said, was that after the meeting was over he entered into a wordy altercation with Professor von Hutyra, but preserved a respectful silence towards Sir John M'Fadyean.]

VETERINARY SURGERY

A Short Review of its Present Standing.

By J. G. Wright, F.R.C.V.S.,
Professor of Surgery, Royal Veterinary College, London.

It is my privilege to be entrusted with the task of writing a short article on the influence of the teaching of our esteemed professor, Sir John M'Fadyean, on clinical veterinary surgery, in this *Festschrift* prepared to do him honour. Whilst Sir John was essentially a pathologist and a research worker, it will be recognised at once how profoundly his teaching influenced the attitude of his students to everyday clinical problems. Was it not from him that we first learned of the nature and causation of disease; the processes by which injured tissues undergo repair, and the principles of bacteriology?

The Basic Principles in Surgical Interference upon Animals.

It is appropriate at this moment that those of us who engage in clinical science, for science it is if we practise it in accordance with Sir John's conception, shall recall those basic principles, in case there has been a tendency, as the years go by, to disregard them. Let us keep before us a clear picture of the principle that the power of repair is an inherent property possessed by all living cells; that it results from a process of proliferation of the vascular and connective-tissue structures of the injured part, and that the chief function of the surgeon, in all his actions, is to eliminate any factor which tends to prevent or even delay this natural process. Of these factors continuous or frequently repeated irritation is, from the surgical viewpoint, the most important. Such irritation may arise from a large number and variety of sources. The first and foremost is invasion of the tissues by pyogenic bacteria, and it is generally the most serious, for not only does its action tend to be cumulative, but in addition, consequent upon the absorption of toxins, severe systemic illness may arise which may possibly jeopardise the life of the subject. Other important causes are:—the absence of rest in inflamed tissues, the action of foreign bodies in or on their surface, the destructive action of chemical agents used for so-called disinfection, etc. In this connection one recalls a happy memory of student days—Sir John, in his lecture on the causes of sepsis, had stated that pyogenic organisms were ubiquitous; a few days later he recounted, with a twinkle in his eye, that he had been told in an examination paper, that the cause of sepsis was the *Bacillus ubiquitosus*.

All accidental and the great majority of surgical wounds are, to a greater or lesser degree, infected. This, however, does not imply that the wound must necessarily become septic. Whether it does so or not may be largely due to the manner in which surgical inter-

ference has been carried out. Healthy living cells are, up to a point, well able to look after themselves. Were it not for this fact the animal kingdom would long have ceased to exist because of sepsis. It must be constantly borne in mind that most surgical interferences are, in themselves, destructive, but that they have become necessary to eliminate some factor which prevents natural repair occurring. Thus every effort must be made to reduce the degree of destruction to a minimum. It may be asked how may this best be effected ? In the first place it must be ensured, by the adoption of relative asepsis, that no other and possibly more virulent organisms are introduced into the tissues. All instruments must be sterilised by boiling ; the operator's hands must be thoroughly scrubbed, and wherever possible the patient's skin denuded of hair and thoroughly washed. On no account should it be assumed that the plentiful use of the so-called antiseptics relieves us of this necessity. Great care must be taken that the vitality of the tissues is not greatly reduced consequent upon long exposure and rough usage. We might with advantage recall Sir John's telling us of the inflammatory processes to be observed in the frog's mesentery on mere exposure. Operations must therefore be performed with the utmost speed and gentleness. Excessive bruising by the rough use of forceps and other clamping instruments must be avoided. It must be borne in mind that blood clot makes a perfect medium for bacterial multiplication, and thus on no account should hæmorrhage be ignored, but every effort made to control it as the operation proceeds. Dead space in the tissues which favours hæmatoma formation, should, as far as possible, be eliminated by appropriate suturing or bandaging. On no account should destructive chemical agents be used for their disinfectant properties, for it is highly improbable that they will kill bacteria in concentrations lower than those in which they kill tissue cells, and speaking generally, of the two evils it is probable that the chemical agent is the greater. In the treatment of most accidental and many surgical wounds, it becomes necessary to ensure that there is effective drainage for the escape of pus. The complete closure of such wounds by suture, by imprisoning infection, not only increases the degree of local tissue destruction and delays healing, but may even endanger the life of the patient. It is often our duty to enlighten a misinformed public on this point.

The actual cautery has long been used in veterinary practice as a method of arresting hæmorrhage. Despite this fact it is well to consider its action critically before resorting to it, for destruction of the tissues by the hot iron is invariably followed by necrosis and bacterial invasion, and first-intention healing—the aim of all operative surgery—becomes, to all intents and purposes, an impossibility. Before employing it, it should be considered carefully whether or not other, and more simple, methods of arresting hæmorrhage, might not serve equally well. If the decision is that they will not, then let the application of the iron be as limited as possible.

Much of our surgical practice relates to the treatment of sepsis.

Let us remember the dictum of Celsus—" where there is pus—let it out," for it has as much force to-day as it had when it was uttered, centuries ago. The moment the presence of pus in the tissues is established it is our duty to liberate it by effective incision. Surgical interference cannot be effectively replaced by the more simple methods of fomenting, blistering, etc., for if a local abscess, other than a most simple superficial one, is allowed to take its natural course, a chronic sinus not infrequently results.

As veterinarians it is our task to perform certain operations upon healthy, normal animals. Generally the subjects are young and their tissues are, from a surgical viewpoint, exceedingly beautiful. Our only possible aim must be 100 per cent. success. Not only must there be no deaths as the result of operative interference, but in addition there should be no post-operative sepsis and little or no malaise. That we do not get these results must serve as the spur for a critical examination of our methods.

Anæsthesia in Veterinary Practice.

One of the greatest problems of surgery is that of anæsthesia. The veterinarian is usually called upon not only to perform the operation but administer the anæsthetic in addition. Our difficulties are increased by the number of species with which we deal, for they exhibit great variations in size, temperament, and anatomical and physiological development. Not only does the response of each species to anæsthetic agents vary, but in addition, there is marked individual variation within each particular species. Whilst it may be accepted as a general principle that the type of anæsthesia selected should be the safest available, and that local or regional anæsthesia should be adopted whenever possible, a factor which cannot be ignored in veterinary surgery is the very natural fear which a conscious animal exhibits on being restrained and the efforts which it may make to free itself greatly add to the risks of operation. Thus, for many interferences which in man might be perfectly well carried out under simple local infiltration, we are compelled to adopt deep narcotisation or even full general anæsthesia. These remarks apply especially to the horse and dog, and in these species, improvement of our methods of anæsthesia must be one of our constant studies, for quite apart from the humanitarian aspect, efficient technique is only possible under perfect anæsthesia.

Casting of the fully-conscious horse is undesirable and not entirely free from risk. At the same time the administration of narcotics to the animal in the standing position is by no means an easy matter. The oral and stomach tube methods are, to say the least of them, cumbersome. Some method of hypodermic injection is obviously much to be preferred, but when one considers the drugs which are suitable for this species both from the narcotic and economic standpoints, it is found that none are suitable for simple, subcutaneous injection, and that the intravenous route must be employed. Quite

apart from the technical difficulties of this method, which, when dealing with agents such as chloral hydrate, are by no means negligible, the rapidity of the onset of narcosis, a factor which is so valuable when dealing with the small species, is a disadvantage in the horse. The animal may flounder and fall before the injection is completed with the result that not only is the required depth of narcosis not attained, but, when working in a confined space, the animal may sustain injury. Again, it happens that the non-volatile agents that are available for the induction of narcosis in this species are comparatively slowly broken down and excreted, with the result that when deep narcosis is attained the animal may remain recumbent for several hours.

During this period it has to be carefully watched, and possibly restrained, for not infrequently the period of recovery is associated with excitement, during which the animal not only exposes itself and its attendants to a risk of injury, but in addition may negative the attempts made to attain clean surgery. It may be said, why bother with narcotics ?—cast the animal and administer chloroform, for recovery is rapid once administration ceases. This is conceded, but it must be pointed out that to induce chloroform anæsthesia in any animal, other than the smaller subjects, without previous narcotisation, generally necessitates curtailment of the animal's air supply, with partial asphyxiation. Whilst this method has given quite good results for rapidly performed interferences, it is unsatisfactory when even and continuous anæsthesia for longer periods is required. In this connection the great value of systematic subcutaneous or perineural injection of local anæsthetic agents as an adjunct to narcotisation or light chloroformisation must not be overlooked.

The dog is the other species in which general is preferable to local anæsthesia, for all other than the simplest interferences. It is the species in which we have the greatest surgical scope and there is no doubt but that the recent rapid enlargement of our field of usefulness has, in no small measure, been due to advances that have been made in our methods of inducing general anæsthesia. A similar statement may be made regarding cattle practice, for the advances which have been made during recent years in bovine obstetrics have been largely due to the introduction of epidural anæsthesia in this species.

The greater part of our surgery, however, is performed upon diseased animals, and in these the difficulties become increased. Progressive intoxication and inappetence greatly reduce the protective powers of the liver, with the result that susceptibility to anæsthetics becomes greatly increased. In addition the lowered vitality of the tissues affects adversely, not only the rate of healing, but their ability to withstand pyogenic infection, and thus in these cases it becomes incumbent upon us to observe with even greater strictness the principles which have been outlined earlier in this article. Yet there are a large number of fatal conditions in animals which can be overcome by prompt surgical interference, and in many of them the

outcome is largely dependent upon the time at which operation is performed. The greatest factor in surgical success is skill in diagnosis and this is dependent upon a sound conception of pathology. The more promptly the operation is performed once the diagnosis is established, the greater are the chances of saving life. Not a little courage is required, in many cases, to embark upon it, yet procrastination is our greatest enemy.

Let me remind those who like myself have selected clinical science as their *métier*, of Sir John's graphic description of the course taken by the nail the cow had swallowed—a surgical condition if ever there was one. Despite the fact that the Scottish farmer forbade his dairy-maids to use hairpins, cows still die from this disease.

If each one of us, as the result of his own careful observation, shall add one fact to the common fund of veterinary knowledge, we shall be erecting an edifice worthy of our great teacher.

"RHEUMATIC DISEASE" IN THE HORSE
(OSTEO-ARTHRITIS AND ALLIED CONDITIONS)

By W. M. Mitchell,
Professor of Surgery, Royal (Dick) Veterinary College, Edinburgh.

In the early years of this journal the diseases of the horse received much more attention than they are having at present. This is only natural as in those years the horse played a much greater part in the daily life of the community and the everyday work of the veterinarian. All who still retain an interest in the diseases of the horse will not find a better source of study than the early numbers of this journal. The present writer now acknowledges the debt of gratitude he owes to the many outstanding men of that time who recorded their experiences and observations in its pages.

Having in mind the subject about to be discussed in this short review the writer would like here to express especially his profound admiration for the work of the late Sir Frederick Smith, whose papers on many of the disabling conditions from which the horse suffers are really classical. Their great value lies in the clear correlation of clinical signs and pathological study of lesions, founded upon an accurate knowledge of normal anatomy and physiology. The scientific honesty of the man which commands such respect can be illustrated by a quotation from a paper in which he is discussing the etiology of navicular disease. After explaining how he considers 10 per cent. of the cases are due to compression of the bone he says, " I cannot positively say how the remaining 90 per cent. incurred the disease ; I suspect that a weak bone, irregular blood supply, irregular work, senile decay, hereditary predisposition and concussion all take their share, but the exact proportion to be allotted to each of them it is obviously impossible to state " (Smith, 1893). Smith's methods of study of the various clinical conditions affecting joints, correlating clinical signs and pathological appearances with the anatomy of the parts affected, embodied the

Major-General Sir Frederick Smith, C.B., K.C.M.G., Hon. Assoc. R.C.V.S.

1857-1929.

". . . Putting aside the many valuable articles which he contributed to this and other professional journals, he was the author of four works of outstanding merit, *viz.*, text-books dealing respectively with Veterinary Physiology and Veterinary Hygiene, a History of Veterinary Science (down to the end of the 18th centuary) and a History of the Royal Army Veterinary Corps. . . . He appeared to be inspired by a determination to contribute his utmost to the advancement of veterinary science. . . . [this Journal (1929), **42**, 212].

guiding principles upon which the writer started to investigate the condition known as " Shivering." This investigation very soon led to his linking up this apparently nervous disease not only with the conditions spavin, ringbones and navicular disease, which Smith regarded as closely allied, but with many other chronic disabling conditions which diminish the usefulness of the horse. This work is dealt with elsewhere (Mitchell, 1930-36) and what follows in this article is only a brief outline of its gradual development.

The present investigations were suggested as a result of the frequency with which irregular bony nodes were noticed on the bodies of the thoracic vertebræ of horses destroyed at the Scottish Zoological Park for feeding purposes. The lateral surfaces of the bodies of the thoracic vertebræ (6-18) have no muscular covering so that even small nodes can be detected in a carcase at a glance. It was thought that the clinical signs of Shivering might be due to pressure from exostoses, similar to those seen so commonly in the thoracic region, upon nerve roots emerging from the ventral intervertebral foramina before joining the lumbo-sacral plexus. The first horses (3) post-mortemed which were shiverers were aged, and this idea of pressure upon nerve roots in the lumbar and sacral region seemed to be strikingly upheld. Other closely allied conditions such as Partial Paraplegia (" Jinked Back ") and Stringhalt appeared in old horses to have a similar relationship. About this time it was recognised that whenever there was evidence of osteo-arthritic change in the vertebral column there were almost invariably clinically manifested osteo-arthritic lesions in the limbs, especially in the phalangeal region. Conversely, it was found that horses with clinical osteo-arthritic lesions in the limbs invariably showed some degree of osteo-arthritis of the vertebral column.

The preliminary investigation of shivering and allied nervous conditions had been undertaken on old horses. It was then felt that factors such as old age and the wear and tear of work might account for the gross lesions affecting bones and joints, and that the notion of pressure upon nerve roots at the intervertebral foramina as a cause of the nervous derangements might only have arisen through a coincidence. For this reason, the next stage in the investigation of shivering was directed to the examination of young horses that were affected and had done little or no work. The gross changes found in old horses in the lumbar region of the vertebral column were not found in the young horses. The idea that shivering was due to pressure upon nerve roots emerging from the intervertebral foramina had therefore to be abandoned.

These young horses were, however, subjected to a detailed general *post-mortem* examination and, in view of the common association of shivering with joint and bone lesions in the old horses, special attention was directed to examining the joints and bones. As far as the joints were concerned it is sufficient to state that no horse which showed signs of shivering was free from pathological changes in many joints

throughout the body. These changes were sometimes very advanced, though the affected animals did not necessarily show clinical signs during life. Before the joints were examined, the main peripheral nerves of the limbs were exposed. In a few cases, serous exudate and, occasionally, petechial hæmorrhages in limited areas were visible in some of them, the femoral and sciatic nerves being the commonest to show these changes. It was not until routine microscopic examination was carried out that the vast amount of damage to the peripheral nerves was appreciated. It has not been possible to obtain *post-mortem* material showing the early changes in peripheral nerves, for it is realised that by the time an animal exhibits clinical signs the changes in the nerves are far advanced. These advanced changes take the form of scattered patches of fibrosis replacing degenerated nerve fibres in the nerve bundles. The whole of the nerve fibres in an individual bundle are not destroyed though as many as two-thirds of the nerve fibres may have disappeared in a transverse section of an affected nerve. There does not appear to be degeneration of the nerve fibres above and below one of these localised patches where the nerve fibres are destroyed and the writer is completely at a loss to account for this restriction of the lesions.

Although the joints and peripheral nerves are the most constant seats of lesions in horses suffering from shivering, various lesions occur elsewhere in individual cases, such as :—

(*a*) Hyperplasia of lymph nodes (very common).

(*b*) Fibrositis of the terminal part of the œsophagus.

(*c*) Atrophy of laryngeal muscles ; degeneration similar to that seen in the peripheral limb nerves has been found in the left recurrent nerve in one case.

(*d*) Ulcers in the œsophageal portion of the gastric mucous membrane.

(*e*) Verminous aneurysm of the cranial mesenteric artery (very common).

The widespread distribution of disease throughout the bodies of horses destroyed primarily because they were shiverers became more and more impressive as the investigation proceeded. Meanwhile, in a still wider sense this composite syndrome acquired an increasingly suggestive significance when general *post-mortem* examinations were made upon horses that were affected with well defined localised clinical joint lesions but showed no clinical signs of nervous disability. Not only did we find in these horses that joints other than the one clinically affected showed hidden pathological lesions, just as we had found in horses that were shiverers, but there was discoverable in them also disseminated peripheral nerve degeneration. The widespread damage to the peripheral nervous system is probably of supreme importance. Many of the clinical signs of interference with the proper functioning of the various organs and tissues of the body may depend upon this derangement. When the motor fibres in peripheral nerves are destroyed, then, depending upon the degree of

destruction, clinical signs of interference with the normal smooth functioning of muscles may occur. Thus, a horse may be classified as suffering from shivering, stringhalt, partial paraplegia, or roaring, and, though we have as yet no definite evidence, functional heart disease may also arise from nerve damage. Even when there is no apparent loss of control over voluntary muscles, the damage to motor nerve fibres may be sufficient to diminish control over the muscles, so that sprains of the attached muscle tendons are more liable to occur. The work of Dale (1929) throws light upon the manner in which damage to sensory nerve fibres will cause vasodilation of blood vessels. It is possible that the bony exotoses and joint changes observed in horses may depend partially upon the disturbed nutrition initiated by nerve degeneration. Nothing abnormal, either macroscopic or microscopic, has been observed in the spinal cord in a number of cases examined at a stage when well developed lesions in the peripheral nerves were present. No work has yet been done on the autonomic nervous system.

From the beginning of these investigations ten years ago the possible causes of this composite syndrome which we have provisionally named " Rheumatic Disease " have been repeatedly under review. The doubts which Smith expressed about the causes that had been suggested to give rise to navicular disease have always been kept in mind. And especially the importance to be attached to heredity in the causation of osteo-arthritic conditions has been under scrutiny. These doubts have been intensified by the steadily increasing impression gained that the osteo-arthritic lesions arise as a generalised state in which peripheral nerve degeneration is a coincident phenomenon.

Since the time when Smith discussed the etiology of the equine osteo-arthritic conditions, a new line of approach that may possibly lead to its solution has opened up by the discovery that there are qualitative nutritional factors—vitamins and minerals, an absence or deficiency in amount of which in the foodstuffs may have profound effects on the general health. As yet we do not know for certain whether the horse suffers from a lack of vitamins. Consideration of the common diet of the horse, oats and hay, would lead to the belief that, of the known vitamins, the most likely to be deficient are vitamins A and C. Linton, who is collaborating in this part of the investigation, has shown that as far as vitamin A is concerned the reserves in the liver of the horse may be very low. Out of 133 livers assayed by him, 50 per cent. contained 350 B.U./g and 25 per cent. less than 100 B.U./g. There is now available a great mass of evidence which goes to prove that vitamin A plays a paramount part in maintaining the functional integrity of the nervous system in small experimental animals. As degeneration of the peripheral nervous system has been a common finding in the syndrome under consideration, there is reason to suspect that a deficiency in vitamin A may be a possible contributory cause.

The possibility that the syndrome is also in part due to a mineral deficiency was suggested by Theiler (1934) who drew attention to the close resemblance between the common disease conditions affecting the skeleton of the horse in Europe and the disease *osteodystrophia fibrosa* (" osteomalacia ") which occurs in South Africa, the Philippines, Japan, China, and Ceylon. This disease has been proved to be due to a $CaO : P_2O_5$ imbalance in the diet, clinical signs of the disease developing when the ratio exceeds 1 : 1·8. We have not yet obtained sufficient evidence to decide whether or not osteodystrophia fibrosa and " Rheumatic Disease " are one and the same disease, though analysis of some so-called complete diets used for horses in this country has occasionally shown the $CaO : P_2O_5$ ratio to be outside the limits which are said to produce disease abroad.

Before extending the field of investigation to ascertaining the effects of other food deficiencies, the problem presented by the above two possible nutritional factors, namely vitamin A deficiency and $CaO : P_2O_5$ imbalance demands solution. To this end an experimental station has now been established near Edinburgh, where these problems are about to be tested on ponies as experimental subjects. The funds for the work have been provided through the Agricultural Research Council.

References.

Dale, H. H. (1929). *Lancet*, **1**, 1233, 1285.
Mitchell, W. M. (1930). *Vet. Rec.*, **10**, 89.
——. (1930). *Ibid.*, **10**, 535.
——. (1931). *Ibid.*, **11**, 1126.
——. (1933). *Ibid.*, **13**, 918.
——. (1935). *Ibid.*, **15**, 1501.
——. (1936). *Ibid.*, **48**, 1365.
Smith, F. (1893). *J. Comp. Path. & Ther.*, **6**, 206.
Theiler, A. and Green, H. H. (1934). *Bull. Off. Internat. des Épizooties*, **44**, 65.

SOME PASSAGES FROM SIR JOHN M'FADYEAN'S ADDRESSES AND WRITINGS BEARING ON CLINICAL VETERINARY PRACTICE.

Nomenclature of Disease.

" . . . I may here say a word or two regarding the nomenclature of this disease. If our knowledge of any disease were complete and perfect, the best name to apply to that disease would be one denoting its causation or its primary and essential lesion. But diseases have for convenience' sake to be named as soon as they are recognised and differentiated, and generally long before the cause and exact nature of the morbid processes that underlie the symptoms are known. Hence it is that many affections are designated by terms suggested by their most constant or prominent symptom. As a rule, the name thus conferred becomes firmly rooted by custom before a clearer comprehension of the nature of the disease can suggest the appropriate term under a better system of nomenclature. Referring to the very disease now under consideration, the late Professor Robertson says: ' It is no less curious than interesting to observe how, in the naming of systemic diseases, we cling tenaciously to those chief and characteristic local lesions in which the general or constitutional state has terminated, and upon these bestow consideration and attention, to the exclusion of the larger subject of the disposition or condition to which the local changes may be owing. In this way our ideas, not merely of the nature of these diseases, but also of the principles which ought to regulate our actions in their prevention and treatment, have been correspondingly dwarfed and localised.' But if this applies to cases where the name indicates a prominent symptom or a constant though secondary morbid condition, the force of the objection is increased ten-fold when the name given actually implies the existence of that which is not. The term *azoturia* was conferred upon this disease to express the fact that the presence of a great excess of urea in the urine is its most constant and characteristic phenomenon. But, as I have shown, that is erroneous, and there is no ground for believing that a marked excess of urea is a common, not to say a constant, quality of the urine in this disease. The term haemoglobinuria, when interpreted loosely, expresses what appears to be an actual fact, viz., that hæmoglobin, or some direct derivative of it, is excreted in the urine. The term hæmoglobinæmia, suggested by Froehner, is in one sense better than the preceding, since it carries us a step nearer the initial lesion, implying that the abnormal pigment is present in the blood itself.

" Both of these latter names are still open to the objection that they do not lead the mind to the morbid process that sets this pigment free, or to the exciting cause of that process, but that is because we are yet in ignorance on these points. . . ." (Extract from first article which appeared in this Journal (1888, **1**, 1), The Pathology of Hæmoglobinuria (Azoturia) of Horses, by J. M'Fadyean.

The Period of Incubation in Animal Diseases.

" . . . If a medical student were asked what is meant by the period of incubation, he would probably reply with schoolboy promptness somewhat as follows: It is the period that elapses between the moment of entrance of the contagium into the system and the onset of definite symptoms; and he would probably, with equal readiness reply, if further questioned, that the period of incubation in scarlatina is from three to eight days, in measles about a fortnight, in smallpox about twelve days, and so on.

" If a veterinary student were similarly catechised, his alacrity in attempting to assign a definite or exact period of incubation to each of the specific febrile diseases of the domesticated animals would generally be in direct proportion to his ignorance, and in inverse proportion to his powers of observation and reflection. We have now to explain this paradox. . . ."—Editorial Article. The Difficulty of Diagnosis in Diseases of the Lower Animals. This Journal, 1888, **1**, 349.

The Microscope in Veterinary Practice.

" . . . With reference to Mr. Merrick's statement ' that it was not possible for the everyday practitioner to become a skilful microscopist,' I freely concede that.

If he succeeded in that it would be at the expense of neglecting his other and more important duties. But there are some simple details of microscopic work that are at the command of everybody, and that fill a gap not capable of being closed by any other method. Moreover, by giving the general practitioner a notion of the methods of bacteriologists, interest in these microparasitic diseases is stimulated ; and it is only when that is the case that we are likely to make progress in the direction of knowing more about the causation of such diseases. . . ." —On Some of the Uses of the Miscroscope as an Aid to Diagnosis in Veterinary Practice. (Extract from the reply to the discussion on a paper read by Professor J. M'Fadyean before the Midland Counties' Veterinary Medical Association on February 4th, 1890. *The Veterinarian*, 1890, **63**, 248.)

An Early Injunction to Apply Aseptic Methods in Veterinary Practice.

" In every civilised country, human surgeons now recognise that suppuration is caused by micro-organisms, and among them the aphorism, ' Without micro-organisms no suppuration," obtains universal assent. Moreover, the recognition of the law, and the consequent desire to exclude pyogenic organisms from wounds, have revolutionised human surgery. The same cannot be said of veterinary surgery, in Great Britain at least. We have good grounds for believing that there are many veterinary surgeons practising in this country who do not know that the formation of pus is due to the growth and multiplication of bacteria, and many others who, although aware of the fact, have scarcely made any alteration in their surgical methods since the time when the presence of ' good healthy or laudable pus ' was regarded as evidence of a benignant form of inflammation and promise of a fortunate issue.

" The total neglect or perfunctory carrying out of aseptic methods in surgical operations on the lower animals is probably ascribable to two things, viz.—(1) the difficulty of carrying out a strictly aseptic line of treatment ; and (2) the notion that without any such treatment nature generally conducts the healing processes in animal wounds to a favourable issue, and that the trouble involved would be altogether out of proportion to the benefits obtained.

" That it is much more difficult in veterinary than in human surgery to render surgical and accidental wounds germ-free, and to maintain them so, cannot be denied ; but it is questionable if that difficulty often amounts to an impossibility, and it is quite certain that in many cases it would be well worth while to make a great effort to hasten the healing process by preventing suppuration. It is true that in the case of the horse suppuration in open wounds in the great majority of instances has a favourable issue, but, in the light of some recent discoveries, the complacency with which the operator formerly viewed the formation of pus in a wound that he himself had inflicted can hardly continue.

" To take a single illustration, we know of two grave, and by no means rare, accidents that follow castration in the horse, viz., tetanus and scirrhous cord, which beyond any doubt owe their development to the entrance of microbes into the scrotal wound, and no one will question that, if by strictly aseptic methods of castration the two diseases mentioned could be prevented, very great trouble in the securing of such a result would be well repaid. . . . ."—Editorial Article. Asepsis in Veterinary Surgery. This Journal, 1891, **4**, 255-256.

Veterinary Therapeutics at the Close of the 19th Century.

" . . . In what I have said I have had in mind mainly the advances that have been made in regard to knowledge of the cause and nature of diseases. Naturally, the century has also witnessed great changes in methods of treatment and prevention. Discovery of the cause has in many cases suggested practicable measures of prevention, and in a number of instances it has also led to the discovery of remedies. It must be confessed, however, that the science of pathology, and more particularly of etiology, has during recent years seriously outpaced the science of therapeutics. I have already hinted that the close of the century finds the teacher of pathology in a much happier position than his predecessor of a hundred years ago, but it may be doubted whether the advance of time has in equal degree increased the confidence of the teachers of materia and therapeutics in the efficacy of drugs in the cure of disease. There was no lack of alleged remedies at the beginning of the century, but many methods of treatment in which our forefathers placed much confidence have now been almost entirely discarded. Bleeding is a notable example. The practice

of bleeding was founded on altogether erroneous views regarding the nature of the morbid processes which it was designed to counteract, but, of course, it might have been successful in spite of that, and we know that the practice was thought to be fully justified by the results, apart from any theoretical considerations regarding the nature of disease. There can hardly be a doubt that it killed far more patients than it cured, and the fact that it ever found favour suggests some reflections on the necessity for care in estimating the beneficial effects of methods of treatment. In the case of diseases that are almost invariably fatal (of which, fortunately, there are not so many as was at one time supposed) there would be little chance of error in this direction, but there is obviously much risk of error when what may be called the natural mortality from the disease is not known, and when the practitioner is inclined to record mentally (and perhaps otherwise) every case of recovery as a triumph of his own skill. We are perhaps entitled to regard as one of the advances made during the century that we are more inclined than our forefathers to credit the sick animal with considerable natural powers of resistance to most of the causes of disease, and in the case of bacterial affections we may well hesitate to intervene in the combat, lest our well-meant endeavours should prove fully as embarrassing to defending cells of the animal as to the attacking microbes. At the present time it is the practitioner who is most ignorant regarding pathology who plies his patients most freely with drugs. The profession as a whole are now more careful in the administration of strong medicines in the treatment of internal inflammations, such as pneumonia, and there is no doubt that the recoveries to-day compare favourably with those of the early part of the century.

" Blistering and firing are still much practised, and as therapeutic measures they may be said to have stood the test of the century. Dare one suggest that their reputation is not deserved, or hint that before another century closes they may be as much dicredited as bleeding ? I am afraid that the practitioner who did so would suffer discredit himself, but it is perhaps permissible to suggest that the clinical evidence even of a century might not be conclusive on such a question. At the time when every patient, human and equine, was bled and physicked, there was no clinical evidence as to the merits of less vigorous treatment, and so at the present day it may with much truth be said that the alleged overwhelming evidence in favour of blistering is no evidence at all. Thousands of horses are fired and blistered (which involves a considerable period of rest) ; many get well or are improved, and the result is set down to the counter-irritation. But who at the present time with any considerable practice dares to treat his sprains, splints, and spavins by simple rest without blistering or firing ? The answer is, No one ; and neither the past nor the present furnishes the necessary data from which to estimate the therapeutic value of severe counter-irritation.

" The last few years of the century have put us in the possession of some new remedies of the existence of which our forefathers certainly never dreamt—I mean the so-called anti-toxic sera. It is true that as yet these agents have a very limited value in the treatment of disease, but great developments of this method may reasonably be expected in the future. Already it has put into the hands of veterinary surgeons a weapon with which they can with absolute certainty ward off attacks of traumatic tetanus, provided the owners of animals with wounds will immediately place them under treatment. It may be noticed in passing that the introduction of remedies of this class is another striking example of a valuable discovery which would never have been made without resort to experiments on animals.

" In taking leave of this part of the subject, it may be observed that fuller knowledge of pathology has done much to restrict the administration of internal medicines. It has taught us that for a good many things no medicinal treatment is necessary, since the animal machine is to a very large extent self-repairing. There are no specifics for broken bones ; we put them in position, and confidently leave the process of repair to Nature. We are gradually coming to recognise that not a few of the things that were at one time viewed as being themselves the essence of disease are in reality processes of defence and repair, and not requiring any repression by medication. Practically all inflammatory phenomena are in this sense beneficial, and all that needs to be combated is the cause of them. When that has been effected inflammatory phenomena tend to subside, and in the majority of cases the natural powers of the healthy body will do all that is possible in the way of repair, provided the patient is placed in conditions that are hygienic. When that condition has been complied with, it is doubtful whether Nature can be hurried by medicinal agents, and it is not doubtful that the process of repair can be retarded by them. Great care should be

exercised before saying of any medicinal substance that if it does no good it can do no harm. It is the recognition of these facts that has led us to attach so much importance to good nursing and to all that is included under the term hygiene. . . ."—[Extract from an Inaugural Address reviewing the Progress of Veterinary Science during the Nineteenth Century, delivered at the Royal Veterinary College, London, on October 2nd, 1900. By Professor J. M'Fadyean, Principal and Dean. This Journal (1900), **13**, 266.]

A SHORT HISTORY OF VETERINARY PATHOLOGY*

By Professor E. Leclainche.

In the domain of veterinary science the study of morbid anatomy can be traced back to long before Morgagni's time. The opportunities presented for the dissection of carcases would explain the tendency on the part of observers always to check their hypotheses and diagnoses by *post-mortem* examination. Thus, at all periods in our history, one finds recorded descriptions of the lesions encountered that are sometimes impressive for their thoroughness and these invaluable documents were gathered together with care by the early professors in the veterinary schools and by their pupils. Although the intention may have been not so much to build up a new science as to provide an aid to diagnosis, the collected facts nevertheless came to constitute a most important set of data upon which distinguished teachers like Gurlt and Gerlach were to draw very freely.

Rokitansky's *Handbuch der pathologischen Anatomie* (1841-1846) furnished a systematic account of the lesions according to macroscopic observations ; the histological studies of Virchow and his pupils provided further means of differentiation together with a method of classification based upon cellular changes. For about half-a-century, the study of morbid anatomy was pursued assiduously, especially in Germany, and professorial chairs in this subject were founded at the veterinary schools. These were filled by brilliant exponents, such as for example, in Berlin, by the medical man, Wilhelm Schuetz, a pupil of Koch ; in Hanover, by Rabe ; in Dresden, by Johne ; in Munich, by the medical man Bollinger, and then by Theodor Kitt. The first masterly treatise of its kind published by Kitt in 1894, which afterwards ran through several editions, and the handsome compilation by Joest are everywhere accepted as standard works.

After a period of brilliant study, morbid anatomy fell from its place of supreme importance with the discovery that the cellular or tissue lesions were not specific. With the birth of bacteriology it received only precarious support, and there is a tendency for it to become replaced in the interpretation of disease processes by pathological physiology. The science evolved by Bichat and Virchow retains all the same its full interest from the standpoint of diagnosis and it constitutes the essential basis of that newly developed aspect of professional training which is represented by meat inspection.

Diversified as it is as an objective study, veterinary pathology is eclectic as a body of teaching. What is remarkable is that it derives very little inspiration from human medicine. The first teachers of the subject were often medical men and yet one finds hardly any trace of their early medical training left upon their work. Perhaps they were more impressed than they need have been by the conditions they saw in veterinary medicine. It seems that they declined to transpose the knowledge which they had gained in the study of human medicine to animal pathology and that they broached the latter subject with an entirely fresh mind. M'Fadyean (1923), a medical man and veterinarian by education, has expressed with precise accuracy the kind of mental incompatibility which exists between the two medical specialisations in the following words : " The greatest progress regarding animal diseases has been made in the last 50 years during which period veterinary pathology has, so to speak, commenced to stand on its own legs. The notion that it would be possible to create a class of men with an intimate knowledge of both human and veterinary pathology is a fantastic one, and it can hardly have occurred to anyone who has made himself master of either. In both professions, it is specialisation that has done most to increase knowledge ; and it is by the same process that we must seek to advance. . . ."†

*From *Histoire de la Médecine Vétérinaire*, by E. Leclainche. 1936. (Toulouse). pp. 774-775.

†[M'Fadyean, J. (1923). A Review of the Progress of Veterinary Science in Great Britain during the Past Hundred Years. This *Journal*, **36**, 243-255.]

SOME PASSAGES FROM PROF. J. M'FADYEAN'S WRITINGS ON THE SIGNIFICANCE OF VETERINARY PATHOLOGY.

The Editor's Creed and Mission.

" It cannot truthfully be laid to the charge of veterinary pathologists that they have ever been behindhand in dealing with the etiology of the diseases of the lower animals. Indeed, it has been the bane of veterinary science, more especially in our country, that every one essaying to treat of a particular disease, however incomplete and imperfect his knowledge may be of the morbid anatomy of that disease, must formulate a theory which shall account for the symptoms. One nowhere finds a writer who has the courage to say, ' The pathology of this affection is quite unknown ; let us be slow to theorise regarding it until we have ascertained more than is yet known regarding its morbid anatomy.'

" The custom of giving forth as ascertained and demonstrated facts what are merely speculative theories, has done immeasurable harm in retarding investigation. The recent graduate is too often launched into practice in the firm belief that there is little left for him to learn or discover regarding any of the diseases of the lower animals. He has been provided with a theory that will to some extent account for the most prominent symptoms, and with a rule-of-thumb mode of treatment suggested by the theory. His faculties of observation and inquiry are thereby lulled to sleep, and great opportunities to note and record important facts are therefore allowed to slip.

" To set forth the extent of our ignorance regarding any disease, and to show that the current theories regarding its actual nature are imperfect or altogether erroneous, is to perform a real service to pathology."—The Pathology of Haemoglobinuria (Azoturia) of Horses. By J. M'Fadyean, M.B., B.SC., this Journal, 1888, **1**, 1.

The Scope of this Journal.

" The present number completes Volume 1 of the *Journal of Comparative Pathology and Therapeutics*. We took the somewhat unusual course of issuing our first part without a programme, thinking that the scope of the work to which we had set ourselves would be best unfolded in the subject matter of our first volume. It will not be doubted that the Journal was launched with considerable anxiety as to its future, but we are thankful to be able to say that our fears have been dissipated. The more than friendly criticism that we have received at the hands of contemporary journals both at home and abroad, coupled with a growing list of subscribers and contributors, assures us that there was a void in the current literature of the Science of Medicine (using the word in its widest sense) which our venture will in part fill up. Every day brings forth new proofs of the immense importance of the comparative study of the pathology of man and that of the lower species. In what position would physiological science have been to-day had physiologists invariably confined their researches to a single species ? And may not a comparison of the morbid processes that take place in man and in the different species of domesticated animals, throw as much light on the special pathology of each species as the study of comparative physiology has shed on the functions of the human body ? . . . . "—Editorial Article. The Study of Comparative Pathology. This Journal, 1888, **1**, 348.

The Duty of Meat Inspection.

" To the proceedings of Section III of the International Congress of Hygiene and Demography held in London in August last, a paper was contributed on " The Inspection of Meat with Regard to the Prevention of Disease,' by Dr. Francis Vacher, Medical Officer of Health for Birkenhead. In that paper, the author laments the absence of any organised system of meat inspection in this country, and advocates legislation to compel all sanitary authorities to provide and maintain public abattoirs, to close private slaughter-houses, to license and keep a register of butchers and their premises, and to appoint competent inspectors of meat. Regarding the necessity for immediate reform on these lines there can hardly be two opinions among those who have given any attention to the subject, but there is likely to be less unanimity concerning one important detail discussed in Dr. Vacher's paper. By whom is the inspection of meat in public abattoirs to be carried out ? [Next, follow a statement and discussion of Dr. Vacher's views.]

" Fortunately no such complicated system of meat inspection as that sketched in the paragraph quoted is required. As we said on a former occasion, meat inspection is, for the most part, neither more nor less than the *post-mortem* diagnosis of disease, and it follows naturally that the veterinary surgeon is by his training marked out as the most competent person to undertake the duty."—Editorial Article. The Appointment of Competent Inspectors of Meat. This Journal, 1891, **4**, 253-255.

THE MELANOMATA

By S. Hadwen, D.V.SC., F.R.S.C.,
Ontario Research Foundation.

Vilter (1935) writing on the origin and function of the dendritic melanoblast in the epidermis, mentions the divergence of views among the workers who are studying pigmentation. "Certains, comme Adachi (1903) Hadwen (1931), pensent que la notion du melanoblaste dendritique est artificielle. L'idée d'une cellule pigmentaire rameuse nait de l'accumulation de granulations pigmentaires *libres* dans les interstices interépitheliaux de l'épiderme. La mélanogenèse est assurée grace à l'activité biochimique de la cellule *malpighienne*, qui rejette ensuite son pigment dans les canaux intersticiels.

"La grande majorité des auteurs admet cependant la realité de la cellule dendritique de l'épiderme." "Le pigment des cellules malpighiennes serait d'origine exogène : ce sont les prolongements intra-épidermiques de la cellule rameuse qui assurent le transport du pigment élaboré par le mélanocyte aux cellules malpighiennes voisines."

Vilter reviews the work of Ehrmann and Kölliker, who believe that the dendritic melanoblast originates in the mesenchyme. Winkler (1910) inclines in favour of the ectodermic origin of the melanoblast. Meirowsky (1909), Lignac and Heudorfer (1911) saw a pigmentary neoformation in the malpighian cells, indicating autochtonous melanisation.

Post (1893) observed in birds that epithelial pigmentation of feathers occurred quite independently of the dermis.

Vilter, speaking of the researches of Bruno Block on the dopa-reaction in 1917, thought that Block still left us in the dark about the functional relations between the dendritic melanocytes which are dopa-positive and the melanised malpighian cells. Block admitted also that the dendritic melanocyte represented the active form of the malpighian cell.

Masson (1920-26) refers to the dendritic melanocytes as cells of Langerhans which occur among the basal cells of the epidermis, and demonstrated that the filiform prolongations of these cells attached themselves to the apical pole of the malpighian cells forming the pigmentary caps which are found above the nucleus. Later Masson believed that the dendritic melanocyte originated from nerve tissue. Vilter's paper concludes that the ramous, pigmented cell of the epidermis is the only cell capable of elaborating melanin, which pigment is transmitted to the malpighian cells ; also that the dendritic melanocyte originates in the dermis of human skin.

Having reviewed Vilter's work, the writer will mention some of his own views on the subject which were published in 1931, and will also include a few new facts gathered since that time.

Freckling.

Freckling depends on several factors : exposure to sunlight, the length and colour of the coat, and age. It has been shown that white hair does not protect the skin as well as pigmented hair, hence horses which have whitened with age are especially liable to freckle, and melanosis frequently occurs at the same time. The colour of

the freckles may be rusty red or black and the hairs which grow out of the freckles are repigmented. The most exposed parts of the body, the flanks and face, show freckles, and sometimes large nævus-like spots have been noted. It would appear that a probable reason for the occurrence of freckles is that the epidermis does not possess a sufficiency of melanin to protect itself completely against the sun's rays. In sections from freckled areas, the epidermis shows an irregular production of melanin, the indentations being lined with pigment-bearing cells and the promontories having none.

Melanoblasts and Melanophores.

The writer's opinion has not altered since his paper on the histology of the epidermis was written. Vilter quotes this article fairly, except that he apparently thought the writer did not believe there were dendritic cells in the basal layer. The following quotation is given from the author's paper of 1931 :—

" In the thicker parts of the skin the malpighian cells in the basal layer are cylindrical and are held tightly together, excepting at the sides of the papillæ, where they lie at a different angle and are less tightly packed. All the cells of the basal layer produce melanin and extrude it through dendritic processes. When these cells move up, they leave behind the melanin which they have extruded below and at the sides, pushing in front of them an arrow-shaped cap of melanin granules. As soon as they are released from the pressure of the neighbouring cells they assume a spherical shape (Fig. 5). They now have the appearance of round balls, the arrow-shaped cap of melanin filling up the space between the spheres in the layer above. The pigment becomes less and less noticeable as the cell rises, and another force, that of cornification and hardening, now hinders the advancing cell, so that it flattens out and finally assumes a spindle shape. The cells which enter the ascending stream from the sides of the papillæ meet the stresses in a different way and do not push the melanic cap in front of them—one more often sees loose grains of melanin irregularly scattered round them. The liberation of melanin granules in and near the basal layer explains the contrast in colour between the corneum and the basal cells." " A careful examination will reveal granules scattered evenly everywhere. It is thus possible that there is very little melanin which is actually left behind and, taking into consideration the greater surface of the upper layers, the pigment may be scattered too thinly to produce colour. Fig. 4 is an unstained preparation : extracellular pigment and branching will be noted. The branching has the appearance of issuing from the melanoblasts, but such is believed not to be the case. The branches fit into the interstices between the cells and are simply collections of melanin, *much too large and broad to be dendrites*. The pigment seems to fade out at the top of the photograph, which may be accounted for by a scattering of the granules." "The author has not noted any kind of pigment-producing cell other than the cylindrical type in the epidermis of horses. It should also be mentioned that the melanin granules in the epidermis appear much smaller than those encountered below in the melanomata."

The arrangement of the malpighian cells is not absolutely uniform,

which is, no doubt, due to variation in pigment production in different parts of the body.

The Effects of Leucoderma on the Cells of the Epidermis.

In horses leucodermic spots are common in the perineal region. These may persist for years. The epidermis covering the spots looks normal but lacks the power to produce melanin, though the cells can still perpetuate themselves. Sections were cut and examined from such a case and the animal showed no signs of melanosis *post mortem*. On the edges of spots where pigmentation had started again, abnormal-looking cells were encountered. Outwardly they resemble the cells called " Langerhans " which have been considered malignant. High magnification showed, however, that the so-called cells were in reality basal cells surrounded by an abnormal amount of melanin The most reasonable explanation seems to be that through the effects of disease the cells were over-stimulated to produce melanin. An interesting fact, also, concerning these cells is that as they ascend to the corneum the pigment scatters, so that their identity is lost.

Melanin in the Deep Tissue.

Briefly, it is believed that in the dermis, and in the still deeper tissues, melanin production occurs quite independently of the epidermis. The melanoblasts can be identified especially in avascular places like the peritoneum ; they appear different in shape from the malpighian cells, and may be seen twisting spirally between the interstices of the connective tissue. Pressure no doubt alters their shape and it may be that this same pressure causes the prolongations which are filled with melanin granules.

Experiments.

The writer has not attempted any experiments in the deep tissues, but in the epidermis the production of melanin can be stimulated artificially. Figs. 8-9 show a rabbit in the white skin stage. Injections of diphtheria toxin have caused a growth of black hair round the needle punctures, although the rest of the skin has remained white and there has been no regrowth of fur. The rabbits chosen for testing diphtheria toxin are those which are in the " prime condition," *i.e.*, having a white skin, which occurs when the coat has fully grown. The injections, therefore, have forced a new growth of hair in a dormant skin.

Other injuries such as saddle galls or insect bites may induce a depigmentation or a hyperpigmentation of the skin.

The Inheritance of Melanomata in the Domesticated Animals.

It is known that certain breeds of pigs were commonly affected with " seedy cut," being a deposition of melanin in the abdominal fat. Recently five specimens of epidermal tumours from Duroc

Jersey pigs were secured. These pigs have a cherry-red coloration. Inspector G. W. Starnaman, of the Canadian Department of Agriculture, secured the tumours and states that they are not uncommon in this breed of pigs. Histologically, they show an overgrowth of epithelium with the formation of epithelial pearls. The largest measured 6 cm. by 5 cm. and was raised 1·5 cm. above the surrounding skin. In horses this type of tumour appears rare. The writer has not some across a single case, but Sir John M'Fadyean states that " I consider myself fortunate in this connection in having had an opportunity to examine two examples of the so-called melanotic carcinoma." No mention will be made of the inherited susceptibility of grey horses to melanomata, except to state that the writer is in full agreement with Sir John M'Fadyean's conclusions that in grey horses the predisposition to melanomatosis may have originated as a mutation.

In conclusion, the writer wishes to say that he is pleased to contribute this article, as it is a subject in which Sir John M'Fadyean has shown much interest. It is one on which many workers disagree, but through discussion we may finally throw more light on the true nature of the melanomata.

Acknowledgments.

To Dr. G. W. Starnaman for specimens from pigs, and to Dr. McLure for rabbit skins taken from animals used in testing diphtheria toxin.

References.

Hadwen, S. (1931). The Melanomata of Grey and White Horses. *Can. Med. Ass. J.*, **25**, 519-530.

M'Fadyean, Sir John. (1933). Equine Melanomatosis. *J. Comp. Path. & Ther.*, **46** (3), 186-204.

Scott, W. (1932). Melanosis in Cattle. *J. Comp. Path. & Ther.*, **45** (1), 141-149.

Vilter, V. (1935). Le Mélanoblaste Dendritique des Vertébrés et sa signification fonctionnelle. *Bul. Soc. Franc. de Dermat. et Syph.*, July, 1935, 1-48.

PLATE I

FIG. 1. *Melanoblasts.* Fine dendritic processes are visible, forming a pattern on the surface of central cell. Above it the melanin cap has been formed. The large black cell is producing more melanin than the other cells. At bottom of photograph the dendrites show melanin granules which are being extruded. × 1,600 unstained.

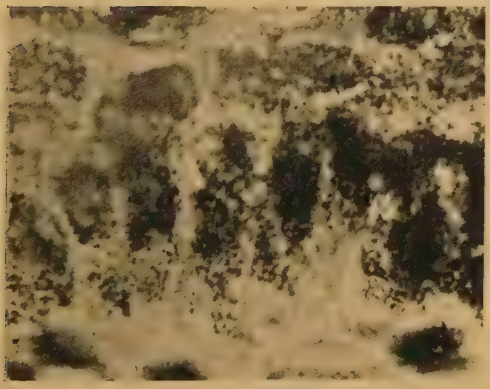


FIG. 2. Basal cells, extruding melanin. Stained preparation. × 1,200.

FIG. 3. Melanoblast from peritoneum. (Courtesy *Can. Med. Assn. J.*

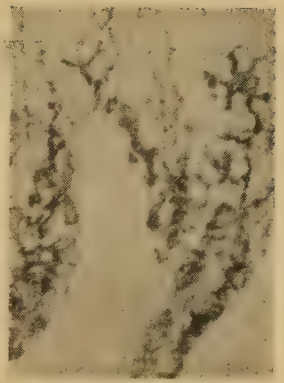


FIG. 4. Unstained section of epidermis. The melanin granules fill the interstices between the cells, giving the false impression of processes emanating from them.

FIG. 5. Malpighian cells unchanged with melanin. Two have moved up, leaving a gap in the basal layer.

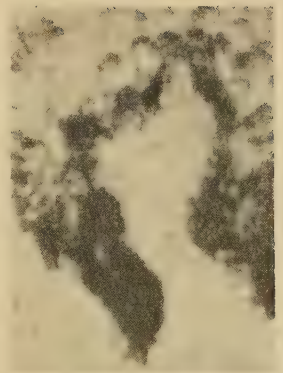


FIG. 6. Disarrangement of basal cells through over-production of melanin.

FIG. 7. A producing melanoblast in the dermis. Note the twisting of cell in the connective tissue.

FIG. 8. Skin on back of rabbit. Black hair has grown on the white skin, following injections of diphtheria toxin.

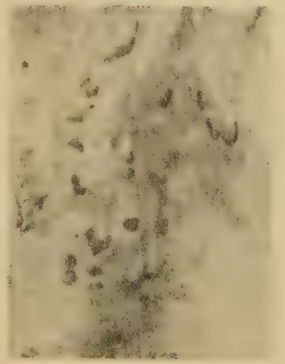


FIG. 9. Same as Fig. 8 reverse side of skin. Pigmented hair roots caused a blackening of skin, at sites of injections.

Figs. 4 to 7 reprinted through courtesy *Can. Med. Assn. J.*, Vol **25.** 1931.

"RUSSELL BODIES," OR HYALINE DROPLET DEGENERATION OF PLASMA CELLS IN THE PORTAL CANALS OF THE SHEEP'S LIVER

By N. H. Hole,

Ministry of Agriculture and Fisheries, Veterinary Laboratory, Weybridge.

Russell[1] was the first Englishman to claim to have recognised the " organism of cancer," and his paper, read before the Pathological Society of London on December 2nd, 1890, appeared in the *Journal of Comparative Pathology and Therapeutics* of the same month. In an editorial article[2], written on the completion of the first volume of the same journal in 1888, Sir John M'Fadyean had emphasised the importance of studies of neoplasms of animals to the clearing up of the cancer problem, and had himself published[3], in 1890 and 1891, a series of descriptive articles on animal tumours. No reference appears to have been made by him, however, to Russell's claim, and if this was due to scepticism of the ætiological significance of Russell's observations, subsequent investigations proved him to be correct, for after some years of conflicting evidence and opinions on the subject it is now generally accepted that Russell's " parasites " are a form of hyaline droplet degeneration that may be found in tumours or in old granulation tissue[4].

The term " hyaline degeneration " is used in a very broad sense to describe changes that occur in tissues or cells that result in the formation of a homogeneous, somewhat refractile protein substance that resists solvents, is usually oxyphil in reaction and does not give the reactions for amyloid[5]. Russell bodies appear to be droplets of hyaline material formed in the cytoplasm of certain cells.

There seem to be very few references to Russell bodies in veterinary literature,* but Cohrs[6] does mention their occurrence in the epithelium of the mouth and fauces in malignant catarrhal fever of cattle. We have observed what appear to be Russell bodies in plasma cells lying among the epithelial cells and in the sub-epithelial tissues of the bile ducts in the portal canals of the sheep's liver. It is difficult to ascribe any pathological significance to their presence. They have been found almost constantly in specimens we have examined from some 30 sheep ; their number is very variable, and seems to be greater if some hyperplasia of the bile duct epithelium is present. The majority of the sheep tissues examined were field specimens from cases of pregnancy toxæmia showing a variable degree of fatty infiltra-

* " Since writing this article the author finds that Joest, in his " *Handbuch der speziellen pathologischen Anatomie der Haustiere* " (1937, **2**, 102) refers to Russell Bodies in the liver in a case of phosphorus poisoning in man (Schmaus and Baum, 1898) and in two cases of liver atrophy in horses (Pöhlmann, 1913).

tion or degeneration, but the bodies have also been observed in the livers from apparently normal animals. They may be connected with some inflammation due to parasitic infection not apparent in the portions examined. Similar bodies have been seen, in small numbers, in a few bovine specimens, but we have not observed them in the liver of man, the horse, the pig, or the dog.

In the sheep these hyaline droplets occur in the cytoplasm of what appear to be plasma cells ; there is a typical eccentric " cart-wheel " nucleus, and a generous cytoplasm packed with spherical bodies of variable size, the larger ones having a diameter of about 8 to 10μ. The bodies appear to distend the cell envelope, for the cytoplasm of the affected cells is considerably larger and more rounded than that of neighbouring normal plasma cells. Twenty or more droplets are frequently observed in one cell. In some instances the cell envelope appears to have burst and to be discharging its contents, but this may well be an artefact of preparation. With some staining methods a refractile rim encircles each droplet, but with other stains the droplet formation is only noticeable under the higher powers. The majority of the affected cells occupy a position immediately under the bile duct epithelium, between it and the basement membrane, and seem to lie in clear spaces in the tissue ; this is seen in Fig. 2. Others lie in the sub-epithelial tissue, and some are situated actually between the epithelial cells as though in the process of diapedesis into the lumen of the duct ; the very occasional occurrence of such affected cells in the lumen of the duct (only when they are very numerous in the tissues) perhaps supports this theory, although here again artefact must be considered, as they may have been " drawn " from the tissues by the knife in sectioning.

Russell originally described the droplets as " fuchsin bodies," and those present in the sheep are definitely fuchsinophile ; in fact they can be stained by the Ziehl-Neelsen method, providing the exposure to acid-alcohol is not prolonged. One minute in 1 per cent. hydrochloric acid-alcohol removes the fuchsin from the tissues and leaves the bodies stained red. Gram's method is another means of obtaining good differential staining, indeed for detailed structure and oil-immersion examination it gives the clearest results, the droplets being Gram-positive (see Fig. 3). In sections stained by Gram's method or by Ziehl-Neelsen it is seen that all the droplets do not stain with equal intensity ; either they do not take the stain uniformly deeply, or they have not equal power of resisting decolorisation. The latter is probably true, as longer immersion in acid-alcohol, or the use of stronger acid-alcohol, with the Ziehl-Neelsen method, leaves progressively fewer droplets stained red. The bodies are also eosinophile, and stain distinctively with hæmatoxylin and eosin, providing regressive staining with eosin is practised. For the sharpest differentiation Mann's eosin-methyl blue gives the best results, the droplets and erythrocytes being the only elements to stain red (Fig. 1). The droplets stain a much darker red than the corpuscles

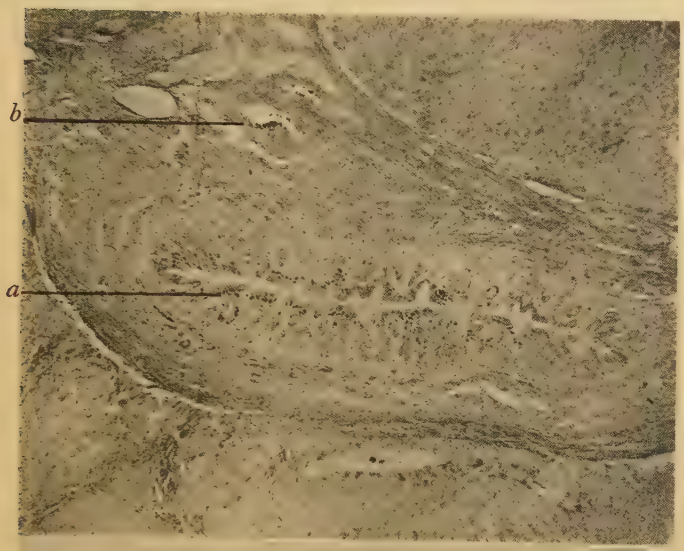


Figure 1. A portal canal from the liver of a sheep showing very numerous Russell bodies. (*a*) Dark red bodies in the bile duct epithelium. (*b*) Bright red erythrocytes in a vessel. The other elements are all blue. Mann's eosin-methyl blue. × 35.

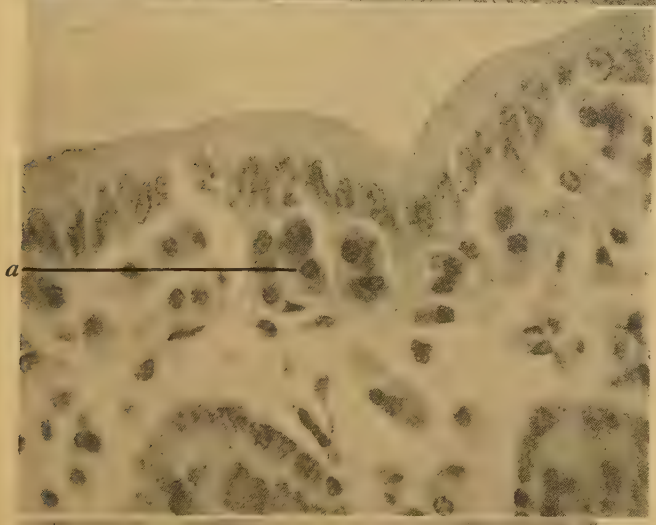


Figure 2. The epithelium lining a bile duct, showing (*a*) the subepithelial position of the packed plasma cells. The droplet formation is indistinct in sections stained by this method. Haematoxylin and eosin. × 300.

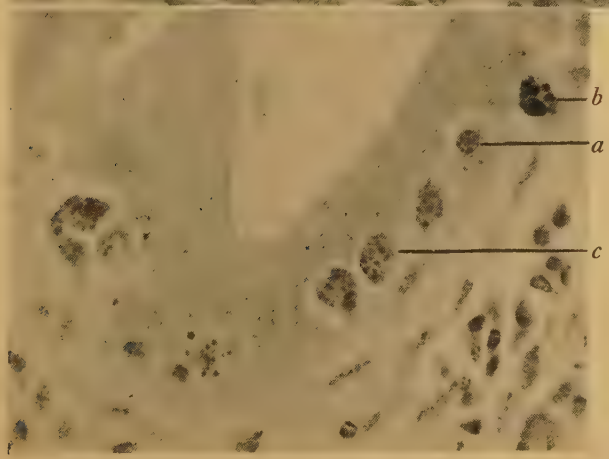


Figure 3. Showing a number of plasma cells containing droplets stained with varying intensity. (*a*) Sharply stained eccentric cartwheel nucleus. (*b*) Deep violet droplets. (*c*) Pale violet droplets. Gram's stain with neutral red. × 300.

by this method. In frozen sections the bodies are not coloured by Scharlach R.

Summary.

Hyaline droplet degeneration of plasma cells in the portal canals of the liver of the sheep is recorded. There is insufficient evidence to suggest any specific pathological significance.

A few similar bodies have been seen in the same situation in the ox, but they have not been observed in human, equine, porcine or canine liver tissue.

References.

[1]Russell, W. (1890). *Jour. Comp. Path. & Ther.*, **3,** 295.
[2]Editorial. (1888). *Ibid.*, **1,** 348.
[3]M'Fadyean, J. (1890). *Ibid.*, **3,** 35, 147, 238, 337.
——. (1891). *Ibid.*, **4,** 143, 243.
[4]MacCallum, W. G. (1937). A Textbook of Pathology, p. 103. Saunders: Philadelphia and London.
[5]Muir, R. (1936). Text-Book of Pathology, p. 43. Arnold: London.
[6]Cohrs, P. (1931). Lehrbuch der Speziellen Pathologischen Anatomie der Haustiere. Nieberle and Cohrs, p. 212. Fischer: Jena.

THE INFLUENCE OF THE VETERINARY PROFESSION ON EMPIRE DEVELOPMENT

By U. F. Richardson, m.r.c.v.s., b.sc.,
Lecturer in Epizootiology, Royal (Dick) Veterinary College, Edinburgh; late Deputy Director of Veterinary Services, Uganda Protectorate.

With the exception of the mutton trade of New Zealand and the wool trades of New Zealand, Australia and South Africa, the units of the British Empire have no spectacular export trades in pastoral products. This is partly due to their geographical positions and remoteness from European markets and partly due to their specialisation in the production of such commodities as minerals, cotton, coffee, rubber, wheat and sugar, which has led to a concentration of population in certain areas and the absorption of pastoral products by the countries themselves.

With the exception of India and certain other Asiatic territories the Empire has been formed by extension into areas which were inhabited by scanty, primitive, nomadic populations, chiefly engaged in hunting, whose only possessions were a limited number of low class stock, kept for transport purposes and the provision of meat and milk.

The early European settlers to these countries went out, as a rule, to develop the production of commodities required by the European market, either by their own labour or by the organisation of native production. As settlements grew they found the pastoral supplies of the countries concerned insufficient for their needs, and attempted to increase them by the importation of animals from their homeland or from neighbouring territories where stock improvement had reached a higher stage of development. Such stock movements tended to disseminate disease, and we find bovine pleuro-pneumonia introduced into Australia and South Africa and surra into Australia, Mauritius and America, whilst the imported stock proved susceptible to local enzootic diseases, such as piroplasmosis, which had previously been unrecognised. The establishment of peaceful conditions and improvements in communications led to the opening up of trade with communities which had previously been isolated, with a further spread of disease, and in many areas, to an actual decrease of the pastoral supplies available. It was at this stage that the necessity for veterinary assistance began to be realised.

Most countries have one or more staple product from the sale of which they derive their prosperity, but any labour absorbed by the export industry reduces the amount of labour available for food production. Since the same amount of food has to be produced, additional labour has to be undertaken by the remaining agricultural workers, and industrial production means a greater activity of the whole populace, which means an improved food ration. An idle people may thrive on a vegetable diet with a minimum addition of animal foods in the form of milk and eggs, and an occasional meat meal on feast days, but as activity increases the demand for concen-

trates and particularly meat increases. The productivity of a country industrially is largely dependent on the availability of adequate and suitable food supplies, and importation of food would raise the cost of industrial production. To a lesser extent the use of animals for transport and cultivation assists largely by increasing the efficiency of labour.

The main influence of veterinary activities has been not to create flourishing export trades in pastoral products, but to preserve and extend the food supplies of the territories, thus rendering them capable of producing other exportable commodities.

In the early days of empire development there was a grave danger of shortage of animals for purposes of food or work. Epizootics periodically carried off large numbers of domestic stock and enzootic diseases prevented any rapid increase of the survivors or any successful introduction of fresh supplies from abroad. The work of Watkins-Pitchford and Theiler in South Africa, Griffith Evans in India, Watson in Canada and Theobald Smith in the United States of America allowed the profession to appreciate the problems with which it was confronted in the various territories, whilst Sir John M'Fadyean, in Britain, recognised their full importance to Empire development, and by his personal studies of such subjects as trypanosomiasis, piroplasmosis and horse sickness and advanced post-graduate teaching of veterinarians in these and allied subjects, inspired an enthusiastic group of home graduates to seek new conquests for science overseas.

With a real appreciation of the necessity of stock conservation by most of the overseas governments and the provision of adequate veterinary staff and equipment, it was a comparatively simple task to control the major epizootics, such as rinderpest and bovine pleuropneumonia. But even now there are many areas where the existence of susceptible game or other peculiar factors have prevented complete eradication. In view of the primary importance of animals as food, restriction of movement has to be so arranged that requisite meat supplies are available, whilst the chance of disease spread is minimised and, if it occurs, can be immediately dealt with. Security to meat producers must be given, or trade organisations become disorganised and, owing to uncertainty in regard to supplies, unable to enter into contracts. It is regrettable that colonial governments whilst willing to provide veterinary staff for the control of disease in breeding areas, that is, to protect the main sources of the supply of animal foods, seem to have failed to supply staff for the efficient supervision of trade routes, that is, to provide for the safety of the distribution of such supplies, although such staff would easily earn its own cost by the reduction of trade losses and the maintenance of regular trade facilities. The result has been, in many areas, disruption of trade activities, the accumulation of stock on the breeding grounds and consequent overstocking for which the owners have been blamed.

With the effective control of epizootic diseases, security of animal life again brings the problem of improvement into the foreground.

This is the stage which has now been reached in the less advanced colonies. In the more settled countries the process of improvement has gone so far that we even find animals for breeding being sent back to the mother country. But even in the advanced colonies there still exists a demand for special animals for special purposes. With the suppression of the major diseases the demand for stock importations recurs, and such movements may now be, not necessarily from the home country, but between the various territories concerned.

Whether such importations are likely to achieve the required result more quickly than improvement by local selection probably depends largely on the circumstances of the case, but that they need very careful control is obvious. With the exception of Canada most of the countries are tropical or subtropical in character. In most areas the animals are tick infested and are carriers of various protozoan and virus diseases which give little indication of their presence owing to an hereditary herd immunity of the animal populations. Such diseases as Rift Valley fever of sheep, Aujeszky's disease of swine, heartwater of goats, East Coast fever of cattle, encephalomyelitis and infectious anaemia of horses appear from time to time in new areas, and little explanation can be offered of their origin. As our knowledge grows of the insidious forms which enzootic disease may assume and the startling manifestations it may display in a susceptible population, we begin to be able to hazard suggestions as to how some of these epizootics originate. That measles was able to kill 40,000 people out of a population of 150,000 in Fiji in 1875 illustrates the virulence a relatively mild disease may acquire in a population with no immunity. The time appears to have been reached when an Imperial study of the disease bearing potentialities of the animal populations of the various areas should be undertaken, not so much with a view to their local importance as with a view to the danger they may be to other territories of the Empire.

Immigrant settlers tend to look to their homelands for the improved stock which will raise the standard of pastoral economics, and when disappointed with the results of importation, to demand the eradication of the enzootic diseases to which imported stock is hypersusceptible. Though the eradication of such diseases will have to be undertaken eventually, the resources and conditions in most territories do not permit it yet. The trained veterinary observer at once notices that local stock is hardy and resistant to local conditions, such as drought, that though often stunted by adverse nutritional conditions and the various diseases which it has had to resist, individuals exist nevertheless which compare not unfavourably with the average European stock both in milk and meat qualities (a milk yield of 30 lb. a day by a native African cow is on record*). He wonders what the potentialities of such animals would be if placed in a more favourable environment and, knowing the objection of the native owners to sell really good animals, wonders whether the best animals

* Kenya Colony. 1936. Dept. of Agric., Annual Report.

have ever come under close European observation. He notes local superstitions and enquires into their origin and applicability to modern conditions. Science more often interprets superstition than discredits it. It is folly for newcomers to class local methods of breeding and management as due to superstition or idleness, or to underrate traditions evolved amongst pastoral peoples by centuries of experience. Some of the traditions have lost their significance, others can be modified by the use of such adjuncts of civilisation as disinfectants, but before a sound scheme of stock improvement can be advised all such problems should be investigated.

The veterinary services are called upon to undertake such work because the disease factor may so largely influence results and because, in their successful struggle against disease, they have acquired the confidence of the local inhabitants and are best able to obtain their co-operation.

Until control of epizootic diseases has been established and its maintenance can be guaranteed, stock improvement cannot be seriously undertaken, even castration of inferior males cannot be advised. The writer encountered one area in which any bull for breeding was unobtainable for months after an outbreak of rinderpest.

Apart from supplying the essential internal services of food and labour, in sparsely populated tropical or subtropical districts, stock populations have a value in the maintenance of soil fertility and in the expansion of settlement. Kraaled at night in the centre of villages, usually on hills, the animals graze by day in the valleys and outskirts of settlements, and in feeding collect material, a considerable proportion of which is deposited as excrement in their kraals at night and helps to maintain the soil fertility of the hillside as it percolates downwards.

As the stock population grows and grazings become inadequate, the animals are taken farther afield ; new water supplies are opened up, new clearings established, desert reclaimed and the waste spaces brought to the service of man. If adequate veterinary assistance is not available to direct or assist attempts, such expansion, in many areas, may be expected to fail. At the best such failures lead to a return of the stock to their old grazings, over-stocking, deterioration of stock through malnutrition, and even soil degradation. Or, an even worse disaster may be, the return of the stock with diseases they have contracted from game or forest flies and the spread of these diseases in previously uninfected areas, loss of stock, loss of soil fertility, encroachment of the jungle and finally regression of settlement.

The veterinary profession, then, may be said to fulfil an essential function in Empire development in the preservation and extension of the food supplies required for industrial development and in the maintenance of the supply of working animals for transport and cultivation. By preservation of stock the fertility of the soil is safeguarded and expansion encouraged, and by stock improvement, based on principles evolved from scientific observation and experiment, surplus pastoral products will become available for the benefit of the Empire and mankind.

POISON PLANTS IN AUSTRALIA

By H. R. Seddon, D.V.SC.,
University of Queensland, Brisbane.

In common with other parts of the globe where large areas of land carrying its natural vegetation are utilised for grazing stock, owners in Australia have to contend with poisonous or otherwise harmful plants as a factor bringing about ill health, and often death, of stock. It is not, however, to these areas alone that poison plants are confined, for they occur also in more closely settled parts—in fact, they may be found in areas from which all indigenous vegetation has long disappeared.

Two factors, above all others, are responsible for the seriousness of the losses due to poison plants in Australia : firstly, the very large areas of land covered solely with natural vegetation, this vegetation including poisonous plants of many species and of varied botanical type ; and secondly, the extent to which stock are travelled from one part of the country to another, often through lands covered solely or almost solely with such natural vegetation. It is well known that stock continuously grazed over areas where poisonous plants occur commonly escape poisoning by them and this is often looked upon as due to such stock having learned to avoid the harmful vegetation. At the same time it is probably not only inexperience which leads to travelling stock being poisoned but also the fact that they are necessarily hungry, there being now much evidence that " empty " stock are often more susceptible than those whose stomachs are well filled.

Even when land has had the standing natural vegetation, *i.e.*, trees and shrubs, removed and the native grasses and smaller herbs have been replaced by introduced grasses and leguminous plants, or

---

[*Note by the Author.*—Australia is fortunately not troubled by many of the serious animal plagues though, apart from them, most of the infectious and parasitic diseases occur here. Thus losses from poison plants assume relatively greater importance than in many other parts of the world.

The result of some of the Australian investigations into this subject have been recorded in the columns of this journal but much, of course, is of purely local interest and has been printed only in Australian veterinary literature.

Probably the most important of Australian poison plants are those which are cyanogenetic and those which cause photosensitisation in stock, and fortunately within recent years much more has been learned about them : about the former, particularly from the work of Petrie, Smith and White and Finnemore, and about the latter, from workers in the sister dominion of South Africa—a country in many respects similar to Australia. There yet remain many suspected plants to be tested in order that one may be certain of their harmfulness or harmlessness, and many fundamental problems remain to be investigated. For that reason, it is felt that there could be no better place than the columns of this journal to present a brief review of the subject. Encouragement in this motive is derived from the fact that to this journal have been contributed not only records of original work—of which there has been no greater contributor and no more careful investigator than Sir John M'Fadyean himself—but articles recording or discussing the prevalence of disease in one or another country of the British Commonwealth of Nations.]

the land has been turned over to agriculture, harmful plants are not necessarily banished from the countryside. Some, especially certain grasses and weeds, continue to form part of the herbage on grazing areas, whilst there often remain tracts of land, unsuitable for cultivation on account of their topography, where the natural vegetation persists. Certainly, in the more closely settled districts losses in stock from poisonous plants are much smaller than formerly : the movement over them of large mobs of stock do not now take place and the harmful plants themselves are relatively much less prevalent than formerly. Yet even in these parts some loss still occurs. It is in these areas, also, that harmful plants of another type are likely to be met. These include fodder crops such as sorghum and sudan grass, both of which are grown for the specific purpose of supplying nutritious food for stock, and those harmful plants which have been accidentally introduced from other countries.

The number of introduced plants in Australia is considerable ; these have either been imported unintentionally in impure seed or gained entrance in vegetable material used for packing. Naturally the majority of these introduced plants gained entrance before the plant introduction precautions now in existence had come into operation.

Native Plants.

In areas where the vegetation is solely native it is often very varied. Grazing stock (cattle and sheep) ordinarily eat only the smaller types of vegetation and seek particularly what is most palatable. They may however browse on shrubs and trees to some extent but in general only when what might be termed " ground " vegetation is scarce. In times of drought stock will tackle the less palatable vegetation, eating what ordinarily they would not touch.

Among the many families comprising the Australian native vegetation, of grasses, herbs, shrubs and trees, it is small wonder that stock get access to a variety of poisonous plants. These include plants which cause sudden death, for example, those which are cyanogenetic, these comprising *Lotus australis* (a herb-like member of the Leguminosæ), *Acacia glaucescens* (also a member of the Leguminosæ, but a tree), *Euphorbia drummondi* (a prostrate herb of the Euphorbiaceæ), *Ximenia americana* (a shrub or small tree of the Olacaceæ), *Eremophila maculata* (Myoporaceæ), *Heterondendron oleifolium* (Sapindaceæ) and *Eucalyptus cladocalyx* (a handsome member of the Myrtaceæ often grown for shade purposes) ; whilst *Cynodon incompletus* (Gramineæ), regarding which there is some doubt as to whether it is strictly indigenous or not, is one of the most dangerous members of this group. Paradoxically, some of the cyanogenetic trees may be intentionally " lopped " when other fodder is scarce, when the mature growth is often eaten with impunity. The young growth, such as grows after such lopping, however, is highly dangerous.

Other plants causing death after an acute illness, but not so rapidly fatal as the cyanogenetic plants, include members of the Leguminosæ, Cycadaceæ, Solanaceæ, Asclepiadaceæ, Compositæ, Myoporaceæ, Passifloraceæ, Rutaceæ, Scrophulariaceæ, Thymeliaceæ and Verbenaceæ.

Other plants again cause serious locomotory disturbance which leads to many animals getting lost through accident (drowning, falling over cliffs, getting cast in places from which they cannot rise, etc.). Some of these plants induce such a craving that animals walk miles daily to seek them out. Another plant is creditably blamed for causing blindness and deafness in horses.

Yet another group of plants is responsible for photosensitisation. With some of them it is curious that year after year they commonly form valuable fodder, the plant being harmful only for a short time during the growing period, and then only when climatic conditions of a certain type have been operating.

Other plants injure stock only mechanically but the loss they cause is by no means negligible. Certain members of the Gramineæ may be referred to here, the awned seeds of which puncture the skin of sheep. This injury is particularly serious in lambs, for, as a result of the pain caused, normal grazing is interfered with and considerable loss of bodily condition occurs. Other grass seeds get into the conjunctival sac of sheep and set up an inflammatory condition of such intensity that, unless treated, sheep may die of thirst through inability to find their way to watering places. Though they do not actually cause ill-health a record of harmful plants would not be complete without some reference to plants which have burr-like seed pods which become attached in large numbers to the wool and seriously depreciate the value of the fleece.

Introduced Plants.

These include :—

(*a*) Fodder plants.
(*b*) Accidentally introduced weeds.
(*c*) Introduced garden plants.

Examples of toxic fodder plants are sorghum and sudan grass, both of which are cyanogenetic. The poisonous action of sorghum, which is particularly marked in the younger stages of growth, is well known in general and steps can be taken to guard against it. The position with sudan grass, however, is by no means so clearly defined. It is commonly grown for grazing but at times it has been responsible for serious mortality. Thus, in dairy herds there are well authenticated cases of animals having succumbed after less than an hour's grazing on a crop which, curiously enough, may have been grazed a few weeks earlier with impunity, and which is subsequently grazed without loss. Such cases have been noted chiefly in certain years when the seasonal conditions have been very different from those usually obtaining, and it is considered that the increased toxicity in

such sudan grass (for it is always cyanogenetic to some degree) depends upon climatic factors.

Accidentally introduced weeds have spread to many far inland areas. If they are palatable they often form part of the diet, for it must be remembered that in most places native grasses do not form a close sward, the rest of the ground cover being weeds. Moreover, during certain seasons, green grass may be scarce and the common greenstuff available may be what would ordinarily be termed weeds, but which is " herbage " to the Australian grazier (as contrasted by him with grass). Curiously enough, some of these weeds bear no harmful reputations in their homelands. In the conditions which prevail in Australia, however, some of these weeds may grow at times so plentifully, and there may be such a scarcity of other fodder that stock may have little else besides them to depend upon for subsistence over a week or longer. In such circumstances it has been shown that one malvaceous and two labiate aliens (*Malva parviflora*, *Lamium amplexicaule* and *Stachys arvensis*) lead to a form of staggers or " shivers " in stock. Actually, these plants have a feeding value, for animals will grow and put on weight when grazing on them, showing no ill effects until travelled. Enforced exercise, maybe for a few minutes only or perhaps for longer, as after an hour's driving, brings about a violent shivering attack, the animals showing some premonitory staggering in gait. If they are pressed to go on such animals commonly die, but if they are allowed to rest and move on of their own volition they may walk for miles without showing a repetition of these or any other ill effects. As the incidence of the condition may be high (over 50 per cent.) one can appreciate the anxiety of a drover who has to take sheep from an area where one or other of these weeds is plentiful and drive them to a place some miles distant. Curiously enough, the same symptoms may follow the ingestion of one or other of two native members of the Polypodiaceæ (*Chelianthes tenuifolia* and *Notholæna distans*). These ferns, which grow for preference in rocky places, are ordinarily not touched by stock but may be eaten by them when other foodstuffs are scarce.

Fortunately for Australia most of the more poisonous pasture weeds of other countries have not gained entrance here. *Datura stramonium*, *Euphorbia peplus*, *Anagallis arvensis* and a few others are present but cause little loss. One weed of other countries which is in reality not an introduction but a cosmopolitan, namely, bracken fern, at times causes trouble and is perhaps of more than passing interest in view of its occurrence in Britain. Stock in Australia ordinarily do not eat it, at least in any considerable quantity. During dry winters, however, they may do so through scarcity of other fodder, when it brings about symptoms and lesions of gastro-enteritis, such as was found by Stockman and recorded in this journal. Bacteriological examination, however, shows that this gastro-enteritis is accompanied by a septicæmia due to an organism of the coliform group. The disease resembles pasteurellosis but the organism does

not appear to be a pasteurella, though in stained blood smears it shows a bipolar appearance. Another noxious plant (*Martynia proboscidea*), rather appropriately termed " devil's claw," has a seed pod with long recurved hooks which, by entangling the legs of sheep, may completely impede walking, or, by becoming affixed over the muzzle, feeding by the animal.

Of the garden plants recognised as poisonous in other lands few other than those of tropical and subtropical climes appear here. Even these do not commonly poison stock but, as in all countries, cases of poisoning occur from :—

(*a*) Garden refuse to which stock acidentally gain access,

and (*b*) Garden escapes in pasture lands.

Fortunately the plants of this group cause little loss, but here one is glad of the knowledge accumulated in older countries. Perhaps the most poisonous is *Nerium oleander*, a shrub much grown about homesteads owing to its suitability to Australian conditions and the beauty of its flowers. Yew is little grown and acorn poisoning unknown, though in many parts we are fortunately able to cultivate the British oak, the wood of which was used to build the ships that brought the first settlers to these shores.

PATHOLOGY AND THERAPEUTICS OF NAGANA: AN APPEAL

By H. E. Hornby,
Director of Veterinary Services and Animal Husbandry, Mpwapwa, Tanganyika Territory.

I feel sure that when the title of this journal was decided on, it was not by chance that " therapeutics " was placed after " pathology " ; certainly as an undergraduate, when it was my privilege to study under Sir John M'Fadyean, I formed the opinion that rational therapeutics were dependent on and therefore preceded by pathology, and I have no reason to change my opinion since those far-off days.

In the field of the trypanosomiases, however, great steps towards successful curative treatment have been made without corresponding advances in knowledge either of the effects of the parasites on the hosts' bodies or of the manner in which treatment stays these effects, and the result is a system of empirical treatments that is as scientifically unsatisfying as was the udder-inflation treatment of milk-fever before its *modus operandi* was understood. I feel that the wonderful achievement represented by the discovery of Bayer 205 and its application to the control of certain trypanosomiases is a triumph of the chemist aided by the physician, without any help from the pathologist.

There is little doubt that had pathology kept pace with chemotherapy a satisfactory system of rational treatment would exist to-day in place of the present unsatisfactory empiricism. For what is the position with regard to the therapeutics of African animal trypanosomiases to-day ? Briefly it is this :—

Recent infections with any of the larger polymorphic trypanosomes (*T. brucei*, *T. rhodesiense*, *T. gambiense*) or with the allied parasites of surra (*T. evansi*) or dourine (*T. equiperdum*) can be treated with much hope of success by injections of Bayer 205. Other drugs that may be used with some confidence include Styrylquinoline 314 and, possibly, Tryparsamide. Advanced cases of infection with any of these parasites are difficult and sometimes impossible to cure.

Cases of *T. vivax* and *T. uniforme* infection are usually amenable to treatment with either Tartar Emetic, Antimosan, or Surfen C. Practically nothing is known concerning treatment of *T. simiæ* in pigs, though Antimosan cured a sheep experimentally infected with this trypanosome.

T. theileri disease is rare, though by no means confined to Africa, but when it occurs the trypanosomes appear to be unaffected *in vivo* by ordinary so-called trypanocidal drugs, cure resulting entirely from *vis medicatrix naturæ*.

T. congolense disease is the commonest of the African trypanosomiases and the most unsatisfactory to treat, in that the result of treatment is unpredictable. Bayer 205 and Styrylquinoline 314 are of little use. Surfen C frequently gives excellent results, as does Antimosan or Tartar Emetic. Less frequently, but sufficiently often

to be most disconcerting, these drugs, alone or in combination, utterly fail to effect cure.

There is no explanation of these discrepant results. It is utterly incomprehensible why Bayer 205 should be so spectacularly successful in curing early cases of *T. brucei* infection, and yet usually fail to cure cases of *T. congolense* disease. On the other hand, why should Tartar Emetic frequently cure *T. congolense* disease and yet be almost useless for dealing with *T. brucei* ? Why should both drugs account for *T. vivax* and both fail with *T. theileri* ? The difference in action of the two drugs is not detectable *in vitro*. Nor can it be explained by what little knowledge we have concerning accessibility of trypanosomes in the body to the direct action of the drugs : for the trypanocidal ions of Bayer 205 are stated to be less diffusible than those of Tartar Emetic, and it is believed that *T. congolense* is confined to the blood, whereas it is known that *T. brucei* is not so confined, even in the early stages of disease ; one might expect, therefore, that the diffusible antimony ions would have a chance of dealing with *T. brucei* outside the blood-vessels, and that the Bayer 205 particles would eventually account for the *T. congolense* confined to the same closed circulation. But it is not so, and in fact we may as well admit we do not know for certain (*a*) the distribution of any species of trypanosome within its host at any stage of infection ; (*b*) the manner in which any species of trypanosome affects its host ; (*c*) the nature of the immunity responses to infection ; (*d*) the extent to which the action of any drug is direct or indirect ; (*e*) where the destruction of trypanosomes as the result of drug action takes place ; (*f*) whether sterilisation is ever the result of drug action without necessity for any clearing up of stragglers by antibodies ; (*g*) why similar treatment should give different results with similar animals infected with the same strain of trypanosomes.

The literature on the chemotherapy of trypanosomiases is enormous. The literature on the pathology of animal trypanosomiases is so scanty and scattered that a specialist could not work it up into a connected account, and most writers of text-books on animal diseases ignore it altogether.

Hence this appeal : Will not some of those who are working or intend to work on animal trypanosomiases turn their attention to this neglected field of pathology ? Let them not be content to put a chemist's product into an infected animal and see for what length of time the circulation is freed from visible parasites, but let them study the interactions of specific host and specific trypanosomes ; in the one the modifications of function and changes in structure caused by disease, in the other the modifications developed to resist the action of antibodies. One result of this study might well be revelation of the joint in the harness of resistance of the parasite that renders it vulnerable to attack by appropriate drugs ; rational treatment would then replace empirical treatment, and the therapeutics of trypanosomiases at last be based firmly on pathology.

DRUGS OF VALUE IN THE TREATMENT AND CONTROL OF LIVER-ROT OF SHEEP.

By R. F. Montgomerie,
The Wellcome Physiological Research Laboratories, Beckenham, Kent.

It seems remarkable that, despite repeated disastrous epizootics, little specific treatment of liver-rot of sheep was attempted in this country until 1920. A few members of the veterinary profession had used, following upon Continental work, male fern extracts with limited success before the outbreak of 1920-21 introduced the proprietary preparation, then said to be a special extract of male fern, named "Distol," later "Danistol," to many British veterinary surgeons. In the immediately succeeding years this product proved of value in the treatment of liver-rot of sheep, but its limitations became obvious when, in the autumn of 1924, the stage was set for yet another country-wide visitation of this disease. With an efficiency limited by an inability to destroy the less mature flukes, Danistol was available only at a price which made flock treatment prohibitively expensive. The sharp fall in sheep prices of the previous years deterred farmers from using the preparation for any purpose other than in an attempt to save animals obviously doomed. What was required was a drug so efficient, so safe, and so cheap that farmers could readily be persuaded to employ it in dosage of their flocks to prevent the appearance of symptoms of liver-rot in infested sheep and to reduce very materially the spread of fluke ova and the opportunity for future infestation. An investigation with that end in view was commenced by the writer at the University College of North Wales in October, 1924, and it is a pleasure to review this work as a tribute to the stimulating encouragement which Sir John M'Fadyean afforded throughout.

The earlier stages of the investigation were carried through in the face of an epidemic which justified the narrowing of the work to experiments designed to give a rough, yet sound, basis on which flock treatment could be recommended. It was clearly shown that liquid extract of male fern administered in doses which were certainly sub-lethal to sheep destroyed all the *Fasciola hepatica* infesting the larger bile ducts. Younger flukes in the liver parenchyma or very small ducts, however, escaped destruction and re-dosage was often necessary to clear the liver of all the original infestation. Despite that limitation, dosage with male fern extract appeared to be only a little, or not at all, less efficient than treatment with Danistol and was so much more economical that it was widely used for the control of liver-rot during the winter of 1924-25.

In the following season further observations on the use of male fern were overshadowed by the finding that in carbon tetrachloride

we had a drug much more likely to meet the real object of the investigation. Hall, in America, had introduced this drug as of particular value in the treatment of hookworm infestation in man and in animals and had determined its inefficiency in tapeworm infestation. Its efficiency against *Fasciola hepatica* had not been tested. Preliminary experiments on sheep clearly demonstrated its value, for even when the dose was reduced to 0·5 c.c. it destroyed all the mature parasites. While it was shown that the drug could be effectively administered as a drench in a suitable oily vehicle, dosage with 1 c.c. of pure carbon tetrachloride in soft gelatine capsules was recommended after having demonstrated its efficiency in the 172 sheep included in these tests of its value as an anthelmintic against the mature liver fluke. Almost simultaneously Norris, in Ireland, had reached similar conclusions regarding the value of the drug and during the immediately succeeding years carbon tetrachloride was successfully employed on a very considerable scale in this country and abroad.

Interest then turned to the period which elapsed between infestation and assailability of the parasite. This could be determined only by the use of artificially infested sheep and it was shown that approximately 40 per cent. of the cercarial cysts fed to sheep could be recovered, after 12 weeks, as mature or almost mature parasites from the bile ducts. It was further demonstrated that maturity, as shown by the appearance of ova in the rectal fæces, was reached about 11 weeks after infestation. These observations prepared the way for work which showed that the age at which the fluke becomes assailable by carbon tetrachloride varies with the dose administered, becoming progressively less and less as the quantity of the drug is increased. When the period since infestation is 8 weeks or less, dosage with 1 c.c. destroys few of the parasites, while at 9 weeks approximately half are killed and when 10 or more weeks have elapsed almost all have reached the assailable age. When the dose is increased to 10 c.c. even a material proportion of the 4-week " old " flukes are destroyed and few " older " parasites escape destruction. The administration of doses of intermediate amounts confirms this dose relationship between the quantity of the drug and the assailable age, which for 3 c.c. is about 8 weeks and for 5 c.c. about 7 weeks.

There remained the important question of the safety factor in carbon tetrachloride dosage to sheep. American observations had shown that sheep tolerated the drug well and it was soon evident that mountain sheep, seriously affected with liver-rot, showed no toxic effects when even 50 c.c. was administered. It seemed, then, that the safety factor when 1 c.c. was used for the control of the disease was so large that toxic effects could not be expected. Thousands of sheep had been dosed before the first report of ill effects came to hand. Thereafter it became clear that a tolerance to the drug so low that even 1 c.c. produced serious effect, even death, was characteristic of all, or almost all, the sheep of certain flocks, while in others sheep drawn at random regularly tolerated very large doses. These intolerant

flocks were generally encountered in late winter or early spring and were often composed of in-lamb ewes that were in quite good condition and were hand fed or folded on special crops. Attempt after attempt to investigate this problem ended in failure to reduce tolerance, despite the careful imitation of conditions under which poisoning was known to have occurred. Blood analysis gave no hint, rather denied, that intolerance to carbon tetrachloride in sheep is, as in dogs, associated with low calcium intake. The factor, or factors, which operate in flocks to reduce their tolerance to the level when carbon tetrachloride may not be exhibited are as yet undiscovered. Despite this great disadvantage the drug is still in use on an unprecedented scale, at a dose rate of 1 c.c. per head, for the control of liver-rot in sheep. It will be appreciated, however, that in the treatment of the disease the amount administered must vary with the type of infestation.

DOES JAAGSIEKTE OCCUR IN GREAT BRITAIN?

By E. L. Taylor,

Veterinary Laboratory, Ministry of Agriculture.

In the first volume of the *Journal of Comparative Pathology and Therapeutics* M'Fadyean published a brief account of the histopathology of what was considered to be a peculiarly acute form of verminous pneumonia in sheep, the condition having been brought to his notice by two veterinary practitioners, Rowland Dykes, of Wellingborough, and G. Watkins, of Abergavenny.

At first M'Fadyean was puzzled as to the cause of the disease but, on finding large numbers of the eggs and larvæ of lungworms, which he afterwards determined as belonging to the species *Strongylus rufescens*, he came to the conclusion that it was caused by a severe infestation with these parasites.

In 1894 a further paper was published by M'Fadyean on verminous pneumonia in the sheep giving an account of what was then known of the parasites occurring in the lungs of sheep together with a good description of the pathological changes which they bring about. M'Fadyean also referred here to the outbreak of fatal pneumonia in sheep, which was discussed in his 1888 publication, and described the lesions seen in this outbreak as being much more serious than those commonly caused by *Strongylus rufescens*, and quite distinct from the pseudo-tuberculous lesion of sheep's lung which is of comparatively common occurrence in Great Britain.

Of the pathological changes in this severe condition M'Fadyean writes :—

" There is here such a profound departure from the normal structure of the lung that even an experienced histologist might be pardoned for failing to recognise the section as one of lung tissue. The alteration consists in : (1) a great thickening of the alveolar walls, and (2) a peculiar transformation of the alveolar and bronchial epithelium. The former of these changes is due to the development of a delicate spindle-celled connective tissue, while the alveolar transformation consists in the assumption of a cubical or short-columnar shape by the flat epithelial cells that form the lining of the normal air-cells. The cells that line the very small bronchi are also altered to high columnar epithelium, and in some of these the mucus membrane has papilla-like outgrowths projecting into the lumen of the tube. This overgrowth of the bronchial mucous membrane in some cases has a striking resemblance to the lesion excited in the bile-ducts of the rabbit's liver by the presence of the *Coccidium oviforme*."

The full description of the peculiar acute form of pneumonia was not published until 1920, when Sir John M'Fadyean wrote another paper on the " Transformation of the Alveolar Epithelium in Verminous Pneumonia in the Sheep," the purpose of which was, as he states, " To expand a description of a peculiar form of pneumonia in

sheep which occurred in an article published in this journal twenty-six years ago (Vol. VII, 1894, p. 39)."

This article, which is illustrated by excellent photomicrographs, is devoted entirely to the histopathological changes in the lungs of affected sheep, and appears to have met with general acceptance as a good description of the microscopic appearance of a certain type of verminous pneumonia in sheep.

Among the several publications in which reference is made to this paper are those of de Kock and of Cowdry on a disease among South African sheep called *Jaagsiekte*, and on a disease of sheep in Montana called *Progressive Pneumonia*.

These authors always refer to Sir John's paper as a description of a peculiar kind of verminous pneumonia which produces lesions, very similar to those of jaagsiekte and progressive pneumonia, but they do not appear to have considered the possibility of the existence of jaagsiekte in this country and that the lesions seen by Sir John M'Fadyean may have been caused by that disease. De Kock (1929) thought that he could distinguish differences between the microscopical appearance of the lung of sheep affected with the special kind of verminous pneumonia in Great Britain and those affected with jaagsiekte, but Cowdry (1925) writes : " At this stage the proliferations resemble closely those described by Sir John M'Fadyean in verminous pneumonia of sheep. Indeed, a specimen kindly sent to me by Sir John would be difficult to distinguish from jaagziekte except by a consideration of its history."

It is the aim of this note to suggest that the lesions in the lung of British sheep referred to by Sir John M'Fadyean in 1888 and 1894 and fully described by him in 1920 are not those of lungworm infestation but are the lesions of a disease similar to, if not identical with, jaagsiekte.

It recently fell to the lot of the writer to visit Iceland in order to enquire into the association of parasitic worms with an epidemic lung disease of sheep, known there as " Deildartunga disease," which had been thought to be caused by a heavy lungworm infestation. The lesions in the lungs of affected sheep appeared to be identical with those described by Sir John M'Fadyean but investigations in Iceland, carried out in collaboration with Professor Dungal and Dr. Gislason, the details of which are to be published at a later date, led to the definite conclusion that parasitic lungworms could not be held responsible. Efforts to reproduce this disease in experimental sheep in Great Britain by inducing an infestation with lungworms of Icelandic origin, of the species *Muellerius capillaris* (the same as was referred to by Sir John M'Fadyean as *Strongylus rufescens*) also failed.

The verminous pneumonia caused by *Muellerius* has been described as of three kinds, a lobular pneumonia, produced by the adult worms in the bronchi, a diffuse pneumonia in which the eggs and larvæ are found in large numbers in the whole of the affected part of the lung, and a nodular or pseudo-tuberculous pneumonia where the eggs and

larvæ are restricted to well defined nodules in the lung. This is the kind most commonly met with and was described at some length in M'Fadyean's 1894 publication. In the opinion of the author of this note, however, the very characteristic lesions which were described in Sir John's 1920 publication showing the marked extending proliferation of the epithelium, and ingrowths from the lining of the bronchi were not caused by a simple infestation of lungworms, but were produced by a disease similar, if not identical with the one which goes under the name "Jaagsiekte" in South Africa and "Progressive Pneumonia of Sheep" in Montana, and with the epidemic lung disease of Icelandic sheep known as "Deildartunga disease," which will be referred to in the subsequent publication as "Epizootic Adenomatosis."

Whoever has had the opportunity of comparing sections of deildartunga disease with jaagsiekte and the photomicrographs published in Sir John's paper cannot help but remark on the striking similarity between all three conditions, and it is gathered from a private communication of Sir John's to the author that he also leans towards that view; permission has been obtained from him to quote the following passage from this letter in which, writing of deildartunga disease, he states: "since I had an opportunity to examine sections from the diseased lungs of Icelandic sheep sent to me by Professor Dungal, it seems possible that the same disease may occur in this country."

In the paper published in 1920 Sir John refers to "the more recent cases which have furnished the illustrations appearing in this article," and in the letter already referred to states that during the interval between 1888 and 1920 he saw many examples of the same disease in Great Britain. It seems clear, therefore, that the possibility must be acknowledged of the occurrence of jaagsiekte in Great Britain during the past and that, although not in evidence at the present time, having been observed on more than one occasion it is liable to appear again and should be looked for.

Summary.

In 1888 and 1894 M'Fadyean gave a brief account of a lung disease of British sheep, regarding it as a peculiarly severe form of verminous pneumonia. Comparison of the detailed description of the microscopical appearance of lungs affected by this disease, accompanied by photomicrographs which he published in 1920, with those of jaagsiekte and with sections of lungs affected by an epidemic disease of Icelandic sheep (neither of which is caused by parasitic worms) suggest that all three diseases may be one and the same, and that jaagsiekte has occurred in Great Britain.

References.

Cowdry, E. V. (1925). Studies on the etiology of jaagziekte. *J. Exp. Med.*, **42**, 323-333, 335-345.

Cowdry, E. V., and Marsh, H. (1927). Comparative pathology of South African jaagziekte and Montana progressive pneumonia of sheep. *J. Exp. Med.*, **45,** 571-585.

de Kock, G. (1929). Further observations on the etiology of jaagziekte in sheep. *15th Ann. Rept. Dir. Vet. Services, S. Africa*, 1, 169-1183.

——. (1929). Are the lesions of jaagziekte in sheep of the nature of a neoplasm ? *15th Ann. Rept. Dir. Vet. Services, S. Africa*, 611-641.

Dykes, R. J., and M'Fadyean, J. (1888). Lung disease in sheep, caused by the strongylus rufescens. *J. Comp. Path. & Ther.*, **1,** 139-146.

M'Fadyean, J. (1894). Verminous pneumonia in the sheep. *J. Comp. & Ther.*, **7,** 31-42.

M'Fadyean, Sir John. (1920). Transformation of the alveolar epithelium in verminous pneumonia in the sheep. *J. Comp. Path. & Ther.*, **33,** 1-10.

A SHORT HISTORY OF VETERINARY BACTERIOLOGY*

By Professor E. Leclainche.

For a hundred and fifty years veterinary medicine has contributed to the progressive development of scientific medicine in the manner foreseen by the founders of the veterinary schools. Long before the principles of experimental research in this subject had been laid down by Claude Bernard, it was practised by the first teachers at the schools. Erik Viborg found out experimentally in 1797 that glanders was caused by " a contagious poison still unknown in its nature." He reproduced all the lesions of the disease by inoculating horses with glanders pus and found that the virus was destroyed by drying and heating. Bartelémy senior and Dupuy studied at Alfort in 1816 the effects of inoculating putrid material into the veins. In 1818, Girard observed the development of gangrenous swellings after inoculation with foot-rot material. " Numerous and varied experiments " he says, " prove that one may cause similar swellings to develop in the horse and other animals by inoculating them with material that has undergone some decomposition. The experiments prove that all putrid substances contain a *contagious principle* and that inoculation of these substances into living animals produces similar results." Eugène Renault, on repeating Dupuy's experiments in 1833 remarked that " the presence of air is necessary for the onset of putrefaction." He insisted upon the absence of complications in subcutaneous traumatisms, such as muscular ruptures and bistournage. He pointed out that air " vitiated by miasmata is especially dangerous."

The early work upon the etiology of anthrax, which prefaced Pasteur's and Koch's microbial studies, was done almost entirely by veterinarians. In 1836, Eilert, a practitioner at Sangerhausen carried out a series of experiments which proved that anthrax was an inoculable disease and gave clear indications upon the mode of infection and some properties of the virus. Gerlach published confirmation of these findings in 1845 in his memoir, *Die Blutseuche der Schafe*. He recognised that malignant pustule was due to anthrax infection, that anthrax in the sheep and the ox were identical diseases, and that infection persisted in the soil after burial of carcases of animals dead of anthrax. Brauell confirmed the first descriptions of the bacterium already given by Rayer and Davaine and by Pollender, while Delafond observed the growth of the rods and made repeated attempts to " induce them to produce spores or grains."

Before any precise information was obtained upon the nature of virulent infection, empirical methods of preventive inoculation, dating back to variolisation as performed by the Arabs and vaccination by Jenner, had been widely practised. Sheep pox vaccination (*clavelisation*) was commonly applied in spite of the risks entailed, and attempted protection against foot-and-mouth disease by artificial infection (*apthisation*) was adopted, with doubtful results. Although nothing but disasters followed inoculation with the virus of rinderpest, the application of Willems' method caused contagious bovine pleuro-pneumonia to disappear from the greater number of infected premises and paved the way for decisive action in exterminating the disease by slaughter of animals that were clinically affected or had been exposed to infection.

---

*From *Histoire de la Médecine Vétérinaire*, by E. Leclainche. 1936. (Toulouse). pp. 779–784

The problem of virulent infection, the solution of which had engaged the attention of a few thinkers for several centuries, was given exact definition by Chaveau's (1866) researches upon the "corpuscular nature" of the viruses; then, with Pasteur's earliest experiments on the application of the "germ theory" to virulent diseases there was produced a solution in complete form.

From 1880 onwards, discovery upon discovery was rapidly made in the domain of bacteriology and immunology. It was animal diseases that were first of all studied and veterinary medicine found itself intimately associated with all these researches. The principles and methods of attenuating viruses were formulated by Pasteur and for a short time it seemed as if all viruses could be transformed into vaccines by suitable means.

In France, Pasteur received a degree of support from veterinarians which he did not get from medical men. Henri Bouley was the apostle of the new teaching; Nocard was an early disciple. The first applications of the methods of vaccination with the attenuated viruses of fowl cholera, swine erysipelas, etc., were made enthusiastically by veterinary practitioners. In Germany, Schuetz was associated with the experiments of Koch and of Loeffler.

There was a rain of discoveries in the realm of Pasteurian immunisation against animal diseases and veterinarians were the purveyors of these benefactions. Swine erysipelas, anthrax, rabies, etc., were the first to derive benefit from exact methods of prophylaxis.

In 1882, Robert Koch isolated and cultivated the tubercle bacillus, and in 1884 he published his classic memoir on the etiology and pathology of tuberculosis.

During this happy and brilliant period almost every day yielded fresh conquests. Chauveau and Arloing (1880) discovered the bacillus of blackleg; Nocard and Mollereau (1884) isolated the streptococcus of bovine mastitis. With the use of the aniline dyes, Schuetz was able to determine the characters of the bacillus of swine erysipelas, which had been already cultivated by Pasteur (1885); in collaboration with Loeffler, Schuetz (1886) discovered the glanders bacillus; Schuetz demonstrated the streptococcus of strangles; Rivolta and Micellone (1883) described the cryptococcus of equine epizootic lymphangitis and Nocard (1888) the streptothrix of bovine lymphangitis (*farcin du boeuf*). In collaboration with Emile Roux, Nocard (1898) showed that the agent of contagious bovine pleuro-pneumonia was a filterable microbe (*inframicrobe*), thus opening up a way for a large series of fresh investigations.

Whereas until then, great discoveries in medicine had appeared in the form of sporadic eruptions, separated by long distances in time, they now followed upon each other with an accelerated rhythm in regular and uninterrupted succession.

The study of exotic animal diseases produced startling revelations. As far back as 1880, the veterinarian Evans, of the British army in India, discovered the trypanosome of surra, and similar agents came to be found later in numerous diseases distributed throughout the world. In 1888, Smith and Kilborne, in U.S.A., showed that Texas fever—the *tristeza* of South America —was due to a haematozoan (piroplasm) resembling Laveran's malaria parasite.

A new field was opened up with the researches of Behring and Kitasato on the serum therapy of diphtheria and tetanus.

Lorenz (1892-1895) prepared from the pig a protective serum against swine erysipelas. Leclainche (1897) obtained a preventive and curative

serum for gas gangrene due to *Vibrion septique*; Kitt (1899) produced a serum which was effective against blackleg. . . . Serum treatment was found to constitute, in the case of some diseases, not only a striking method of protection and cure, but when they were combined with inoculation of the normal or modified viruses, antitoxic or antimicrobial sera also provided a new means of setting up an active immunity which came to be applied in various ways.

The diagnosis of infectious diseases derived powerful aids from new methods in addition to those of simple identification and the use of the classic procedures of bacteriology such as direct examination, cultural tests and animal inoculation.

In 1890, Robert Koch made known the properties of tuberculin and pointed out the reaction which took place after its injection into tuberculous subjects. The following year, Gutmann, of Dorpat, successfully employed "Koch's lymph" in the diagnosis of tuberculosis in cattle. At almost the same time, the Russian veterinarians, Helman and Kalning prepared mallein, which has rendered services even more decisive than those of tuberculin. Analogous products, such as johnin, abortin, and melitin, came to be applied for the diagnosis of other diseases.

Serological reactions *in vitro* such as the precipitin, complement-fixation, and agglutination tests, provided further methods of diagnosis.

With the close of the 19th century, new discoveries became rarer, in spite of the considerable increase in number of research workers. It had to be admitted that even the most perfect methods are not indefinitely fertile, and on all sides investigation came up against unforeseen difficulties. It seemed as if workers could do no more than glean within the restricted field that had been despoiled of all that was to be easily garnered.

From time to time, however, some new idea surged up as if to bear witness to the perennial productivity of knowledge. The theory of immunisation by means of antitoxins seemed to have reached ultimate fulfilment with the application of serotherapy, when an unforeseen development of theoretical and practical interest comparable to that of von Behring's discovery was revealed, when Ramon described the production of anatoxins.

The dazzling applications of bacteriology to preventive medicine, surgery, and medical treatment have undoubtedly monopolised too much attention. The domain of microbiology, vast as it is in appearance, is nevertheless delimited and other objectives claim attention both for their scientific interest and their economic importance. The study of the parasitic diseases—which bears a parental affinity towards, and is sometimes confounded with, that of the microbial diseases—was [after the creation of the veterinary schools] actively prosecuted in all countries. It is of interest in animal pathology on account of the enormous losses caused by parasitism in all species of animals and in public health in consequence of the transmission to man of certain animal parasites.

In France, Celestin Baillet (1854) carried out numerous researches upon helminths, whilst Delafond studied the mange acari and discovered filarial embryos in the blood of the dog. In Germany, Gerlach (1857) and Fürstenberg (1861) published excellent monographs upon the psoroptic acari of man and animals. In Italy, Ercolani (1859) undertook researches upon helminths, whilst Rivolta (1873) became concerned with vegetable parasites and described *actinomyces*, and Perroncito demonstrated the role of ankylostomes in the anæmia of miners employed in the Saint-Gothard tunnel.

Neumann and Railliet, who wrote classic text-books and very numerous articles gained a world-wide reputation ; they had numerous and brilliant emulators in Germany, U.S.A., Soviet Russia, and elsewhere.

The newer knowledge on nutrition and the part played by various agents, such as vitamins, chemical constituents and internal secretions, in the metabolism of the essential food principles touch upon many points in animal physiology and pathology. Observations made upon animals, in all parts of the world, have contributed invaluable data to a study which also entails painstaking experimental researches.

In view of the subjects treated in the ordinary course of work veterinary medicine has been drawn towards experimentation, whilst the conditions of veterinary practice compel patient and minute observation.

It is upon the animal subject that tests and investigations have always been performed which either respect for the human personality or, may be, the protection conferred by religions and laws have precluded adoption on the human subject. The practitioner himself performs more or less consciously an experiment whenever he departs from standard methods and attempts a new method of treatment.

The true meaning of experiment has come under discussion very often and a serious effort has been made to place a convincing value upon it. It is certain that an experimental result can only have a relative significance even when it is precise and constant. It must be recognised that the alleged determinism of an experiment is often only a lure and that every experimental conclusion contains some measure of uncertainty in objective estimation and still more in the interpretation of results.

Experimental methods, especially as applied to diagnosis, have rendered inestimable services. Criticisms such as have been levelled at these methods are justifiable only when it is laid down *a priori* that they must comprise no error, and such a demand is excessive. The uncertainty of the results is explained by their content of empiricism. They are arrived at by the exploitation of phenomena which are very imperfectly understood and of biological reactions which are so complex that they have hitherto defied analysis.

A reproach of another order has been made against experimental diagnosis. Because of the aids which it gives to the practitioner, it relieves him both of observation upon the patient and of interpretation of the collected facts. One might reply that critical procedures unfortunately find very restricted employment and that the veterinarian has an opportunity in numerous circumstances to exercise his skill as a clinician. The information furnished by experimental procedures cannot be regarded, moreover, as constituting an important element in diagnosis to the same degree as modern exploratory procedures, and its significance and importance have to be taken into careful account. It is not that the methods are in any way at fault but the use that is made of them.

Medicine permits neither the semblance of certitude nor the logical deductions of the scientific pursuits. For us to hope that medicine will become in its turn a science, the human mind would need to be looked upon as competent to discern the mystery of life upon a rationalistic plan, and there is nothing that until now warrants our believing that it is apt to undertake such a task. Its followers may console themselves with the thought that they can place at the service of the art—which also allows of the exercise of personal influence—all the resources of science and their ingenuity as educated men.

VETERINARY BACTERIOLOGICAL PROBLEMS IN SOUTH AFRICA

By E. M. Robinson, F.R.C.V.S., DR.VET.MED., D.V.SC.,

Sub-Director, Division of Veterinary Science, Onderstepoort, Transvaal, South Africa.

— ——

Having been invited to contribute a few pages to the Jubilee Commemoration Number of this journal, the writer felt that the best way in which he could pay a tribute to his first teacher in bacteriology and to the inspiration which he received as a student, would be to give a short outline of the work which has been done on bacteriological problems of veterinary interest in South Africa.

Since his entry into the Government Service as a veterinary research officer in 1913 the writer has been closely associated with much of the bacteriological work which has been done at the laboratory at Onderstepoort.

Before the union of South Africa not much work was done on bacteriological problems and what was done was not of a systematic nature. Jowett carried out investigations on swine plague and a disease known as pneumo-pericarditis in turkeys in the vicinity of Cape Town. Bevan (1907) in Southern Rhodesia investigated an outbreak of pneumonia in calves which he attributed to a pasteurella and in 1912 he published a paper comparing blackquarter in cattle in Rhodesia with the disease known as " struck " in sheep in the Romney Marsh. Bowhill and subsequently Robertson attributed " lamsiekte " of cattle in South Africa to an organism they isolated from the mesenteric glands of cases of the disease, but their findings could not be confirmed.

In the past 25 years, that is since the concentration of veterinary research at the Onderstepoort laboratory after the union, bacteriological problems have been investigated systematically and have assumed great importance. These problems are essentially similar to those met with under European conditions, in contrast to the protozoological and virus-disease ones encountered in South Africa. In order to give a general idea of the work which has been done, it will probably be best to discuss what has been accomplished in connection with particular diseases, taking the more important ones first.

Anthrax.

Nearly all the earlier work on this disease centred round the question of immunisation. In 1915 it was decided to make anthrax vaccine instead of importing it. The vaccine made was essentially the same as the Pasteurian one which had previously been used.

Kehoe (1918) discussed the history of the disease in South Africa and his results with the locally made vaccine. The results were not very satisfactory on the whole, particularly from the immunisation point of view and occasionally inoculated animals developed large swellings. In 1928, Viljoen, Curson and Fourie published a report on their experience over seven years with the spore vaccine for anthrax which had been introduced in 1921 by Kind, who was able to attenuate several South African strains for use in the preparation of the vaccine. This spore vaccine gave very good results in practice. Quin (1929) made a study of methods of immunisation in anthrax and attempted to produce a satisfactory vaccine from extracts or filtrates of the organism but with little success. In the last few years a saponin vaccine of the *Carbozoo* type has been used, at first experimentally, and then on a fairly large scale and has given good results with less tendency to produce swellings such as occasionally are seen with ordinary spore vaccine. In a recent article Sterne (1937) has published the results of his work on dissociation in *B. anthracis*, and has been able to produce an avirulent strain from virulent cultures which would immunize. This avirulent vaccine is being tried in the field but it is still too early to judge of its value.

Gas Gangrene Conditions.

Until 1921 a powdered vaccine of the type recommended by Leclainche and Vallée and made from muscles of sheep, dried, powdered, and attenuated by heat at 100° to 105° C., was made, but was given up in favour of a culture filtrate. Viljoen and Scheuber (1926) described their work on blackquarter immunisation extending over five years. This culture filtrate or artificial aggressin method was given up later in favour of formolised whole cultures which method was found to give a better immunity and the preparation was simpler. Green (1929) gave an account of his work with various types of blackquarter and other gas gangrene organism vaccines and his attempts to elucidate the pathogenesis of the disease in cattle.

In recent years a number of outbreaks of gas gangrene in sheep after shearing have been investigated and found to be due to blackquarter. Scheuber (1931) described the occurrence of *Cl. œdematiens* infection in cases of " crow pick " in sheep.

In 1929 it was found that an organism of the *Cl. welchii* type, corresponding to the lamb dysentery bacillus, occurred in cases of " bloedpens " or lamb dysentery in South Africa where it is of widespread occurrence in certain areas. A formolised whole culture vaccine for this disease has been issued for some years and has given good results in practice. The method of preparation follows very closely the one introduced by Dalling, Mason and Gordon in England.

During this year (1937) an outbreak of dysentery of a rapidly fatal type occurring in young foals at a stud farm has been investigated and shown to be due to an organism of the lamb dysentery type.

Contagious Abortion.

Until 1913 nothing had been done to investigate this disease in South Africa but in that year serological tests were introduced for the diagnosis of the condition. The writer (1918) published the results of his work on the disease over the previous four years, in which many different aspects of the disease were studied and the results obtained by Schroeder and Cotton in America confirmed. A preventive vaccine made from living cultures was issued from 1917 onwards and is still in use. The results from its use have been variable and it is difficult to form any accurate opinion as to its real value. Quinlan (1923) described his experiments with feeding infected milk to calves.

Vibrio fœtus as a cause of contagious abortion in cattle was described by Snyman (1931), and recently the writer (1937) described *Trichomonas fœtus* infection.

Salmonella Infections.

The work on these conditions dates from 1923 when paratyphoid in calves was discovered. Viljoen and Martinaglia (1928) described their investigations into calf paratyphoid due to *S. enteritidis* (Dublin) in the bushveld of the Transvaal. In 1929 Martinaglia published a comprehensive paper on various salmonella infections which he had diagnosed in South Africa, such as fowl typhoid, bacillary white diarrhœa, *S. aertrycke* in pigeons, and *S. abortus equi*.

Recently a big outbreak of paratyphoid in pigs has been investigated in Johannesburg and found to be due to *S. choleræ suis*.

As a result of the importance of the subject in South Africa, the study of the salmonellas is being intensively carried out and a number of articles by Henning are in course of preparation including a study of a large number of South African salmonellas classified by the most modern methods of antigenic analysis. A campaign against bacillary white diarrhœa has been commenced.

Tuberculosis.

The investigation of this disease in South Africa is in its infancy but will develop rapidly in the future as an eradication campaign is to be undertaken. Martinaglia and Paine (1929) described the occurrence of tuberculosis of the bovine type in the koodoo and duiker in the Grahamstown district.

Tuberculin has been made for some years and is now being produced on synthetic media and standardised by intradermal tests on guinea-pigs and cattle.

Glanders.

Apart from the production of mallein and the testing of equines by the complement fixation method very little work has been done on this disease which has all but disappeared from the country.

Botulism.

The work done on botulism in South Africa has been mainly associated with the investigations carried out on lamsiekte in cattle. When it had been established that the cause of the disease was the ingestion of carcase material containing a toxin of the botulinus type attempts were made to isolate the toxicogenic saprophyte and ultimately an organism was isolated which was described as *Cl. parabotulinum bovis*. Subsequently, K. F. Meyer described it as a new species, *Cl. botulinum D*. The writer was able to isolate a few *botulinus* types from various sources in South Africa and the results of his investigations were published in 1930. Scheuber (1929) was able to show that most lamsiekte cases harboured the organism in their intestinal tracts and 10 per cent. of normal cattle did as well.

Miscellaneous Diseases.

A variety of different conditions have been investigated such as aspergillosis in ostrich chicks by Walker (1915) who incriminated *Aspergillus fumigatus*. In 1929 Parkin and the writer described a case of sporotrichosis in the horse due to a sporotrichon of the *Schencki* type. Recently a condition known as " lumpy wool " was shown to be due to " *Actinomyces dermatonomus*," the fungus causing a similar condition in Australia.

In 1926, Quinlan, Steck and the writer described an outbreak of a necrotic pneumonia in horses due to *B. necrophorus*. In 1928 the writer described cases of a fatal icterus in sheep caused by a diphtheroid organism, *Corynebact. ovis*.

Recently several outbreaks of actinobacillosis in cattle have been investigated, and a beginning has been made with a study of the infectious diseases of calves other than paratyphoid and the big subject of mastitis in cattle.

From this short outline of the work which has been done on bacteriological problems of veterinary interest in South Africa an idea can be formed of the nature of the problems which have been faced and are still being investigated. The problems which are now to be studied more intensively, such as tuberculosis and mastitis, show very effectively how closely the bacteriological problems of the veterinarian in South Africa resemble those with which he is faced in Europe.

From occupying a subsidiary position amongst the research problems in South Africa, bacteriology has gradually achieved an important one and there is no question but that its importance must increase as the farming conditions gradually approach those of European countries, and the exotic diseases of the country disappear or are brought under effective control.

References.

Kehoe, D. (1915). *5th and 6th Reports, Dir. of Vet. Res., Union of South Africa.*

Quin, J. (1929). *15th Report, Dir. of Vet. Services, Union of South Africa.*
Quinlan, J. B. (1923). *9th and 10th Reports, Dir. of Vet. Educ. and Res., Union of South Africa.*
Martinaglia, G. (1929). *15th Report, Dir. of Vet. Ser., Union of South Africa.*
Martinaglia and Paine. (1929). *J. Comp. Path. & Ther.*, **42**, 1.
Robinson, E. M. (1918). *Report Dir. of Vet. Res., Union of South Africa.*
——. (1930). *16th Report, Dir. of Vet. Ser. and Animal Ind., Union of South Africa.*
Scheuber, J. R. (1929). *15th Report, Dir. of Vet. Ser., Union of South Africa.*
Snyman, P. S. (1931). *17th Report, Dir. of Vet. Ser., Union of South Africa.*
Sterne, M. (1937). *Onderstepoort Journal*, Jan. & April.
Viljoen, Curson and Fourie. (1928). *13th and 14th Reports, Dir. of Vet. Educ. and Res., Union of South Africa.*
Viljoen and Scheuber. (1926). *11th and 12th Reports, Dir. of Vet. Educ. and Res., Union of South Africa.*

INVESTIGATIONS IN AUSTRALIA INTO SOME OF THE PROBLEMS OF INFECTIONS BY ANÆROBIC MICRO-ORGANISMS IN STOCK

By L. B. Bull and A. W. Turner,
Division of Animal Health and Nutrition, Council for Scientific and Industrial Research, Melbourne, Australia.

In civil life, infections by anærobic micro-organisms are undoubtedly more common in the lower animals than in man. During the early days of bacteriology, far greater attention was given to diseases due to ærobic than to anærobic bacteria. This was probably brought about by the difficulties of cultivating anærobes and by the peculiar nature of many of the diseases, which are characterised by localisation that is rapidly obscured by *post-mortem* changes.

The study of the more modern methods of veterinary pathology and bacteriology in Australia had its origin in the solid foundations laid in Great Britain by Sir John M'Fadyean, whom we seek to honour in this Commemoration Number, and it is not surprising that among the problems to be attacked in the early organisation of veterinary research in this young country were those due to the more obscure anærobic infections.

The cause of the so-called Braxy-like disease of sheep remained for a long time unknown and the first attempt to elucidate this problem was by Gilruth (1910, 1911). A little later, Dodd (1918, 1921) made a very definite contribution by demonstrating that one form of the disease, known as " Black Disease," was due to infective lesions in the liver caused by an anærobic bacillus which he described but did not name. He also suggested the association of liver fluke infestation with the development of the lesions. He did great service in stressing and demonstrating the importance of early autopsies in the study of anærobic diseases. Later, Albiston (1927) suggested that the causal organism of " Black Disease" was *B. œdematiens* (*Cl. novyi*). This work was confirmed and considerably extended by Turner (1928, 1930, 1935) who explained and demonstrated the cataphylactic action of the larval fluke, and developed prophylactic vaccination by means of anaculture that has reduced mortality by from 63 to 86 per cent. This disease has since been found to exist in other countries, including Germany, France, Roumania and Chile. Oxer (1937) has improved the vaccine by adding to it 2 per cent. of potassium alum and thus reducing the dose to one-fifth of the usual amount. This has made possible a single vaccination giving a better degree of immunity than a double vaccination by the older method.

Gilruth appreciated the fact that there was a group of diseases characterised by sudden death in well-conditioned, young animals and lambs, and resembling the braxy of Europe. He did not succeed in differentiating the various diseases, however. A similar type of

disease in lambs was investigated in South Australia by Bull (1926) who suggested that it was an enterogenous toxæmia due to *B. welchii*, which was a conception new to veterinary pathology. Later, Bennetts (1930, 1931, 1932) followed up this work in Western Australia and was able to show that the disease, for which he introduced the name entero-toxæmia, was produced by a special type of *B. welchii* which he named *B. ovitoxicus* and which Wilsdon (1934) has since grouped with *Cl. welchii* Type D. Bennetts showed that the causal organism occurred in the soil of affected properties, that it produced in the small intestine of sheep, possibly under conditions of slight temporary stasis, toxins which could traverse the mucosa, and that the incidence of the disease could be appreciably lowered by prophylactic vaccination with anaculture. Further confirmation of the work was later effected by Oxer (1932) who worked particularly with that form of the disease occurring in young lambs and known colloquially as " pulpy kidney." He (1936) has since shown that, as with the closely related lamb dysentery, active maternal immunity stimulated by vaccination is quickly transmitted to the lamb *via* the colostrum.

Recently Rose and Edgar (1936) have claimed that toxæmic jaundice of sheep in New South Wales is due to the absorption from the small intestine of toxin of *Cl. welchii* Type A, thus bringing it into the enterogenous bacterial toxæmias. The evidence, however, is not complete and so far lacks confirmation.

In the earlier days of the pastoral development, tetanus and malignant œdema were responsible for the loss of many sheep injured in the processes of shearing, castration and tailing, but the introduction of more hygienic methods made their occurrence a rarity in spite of the fact that their causal organisms have a wide distribution as shown by Seddon and Edgar (1930) who found *Cl. welchii* in 100 per cent., *Cl. septicum* in 20 per cent. and *Cl. tetani* in 9 per cent. of soils examined in New South Wales. Heavy losses from tetanus may occur occasionally; for example, Belschner (1925) reported 50 per cent. of deaths in 700 lambs about 9 days after dipping in a filthy arsenical dip. The portal of entry of the organism was considered to be penetrating wounds in the skin produced by grass seeds with which the lambs were heavily afflicted. He (1930) also demonstrated the efficacy and economic value of prophylactic injection of antiserum on a property where annually a loss of up to 1,000 sheep out of 8,000 occurred following shearing. Oxer, Adey and Kennedy (1936) have shown that the use of alum-toxoid may be effective and more economic. Kneebone (1925) reported the death from tetanus of 28 out of 1,000 young sheep in South Australia and suggested that injury to the gums by erupting teeth provided the portal of entry.

Blackleg of cattle and sheep, another example of a gas-gangrene type of infection, has long been known in Australia and for many years was combated with fairly satisfactory results with the old " dried-muscle " vaccine. The ætiology has been particularly studied in calves by Edgar (1929*b*) and in sheep by Seddon, Belschner

and Edgar (1931), *Cl. chauvoei* in pure culture being consistently found. As in other parts of the world this organism was not demonstrated in any of the soils examined by Seddon and Edgar (1930). As a result of their work the older vaccine is now replaced by anaculture with greater safety and much better results. Blackleg in sheep due to pure infection of *Cl. chauvoei* following the cataphylactic, localising action of prophylactic vaccination with sterile enterotoxæmia anaculture (*Cl. welchii* Type D) has recently been reported by Albiston (1937).

Swelled Head or Big Head of young rams is another disease of sheep which may follow trauma. Bull (1928, 1929, 1935) determined the ætiology of this disease in South Australia and advocated the use of anaculture for prophylactic purposes, a measure which has given very satisfactory results. The disease is essentially a progressive subcutaneous, non-hæmorrhagic, malignant œdema originating in the frontal region, caused by infection with *Cl. novyi* (*B. œdematiens*) and initiated in wounds, sometimes insignificant, caused by the aggressive habit of young rams of butting each other's heads. Dodd (1927) investigated a somewhat similar, but hæmorrhagic œdema of the head of rams and other sheep on a property in New South Wales and later Seddon and Edgar (1930) determined that the cause of this type of disease was *Cl. chauvoei*. Edgar (1931) also described another disease of similar type, a malignant œdema or gas-gangrene of the orbital fossæ of sheep, following puncture or enucleation of the eyeball by predatory crows, *Corvus coronoides* or *C. cecilæ*. From the gangrenous orbits *Cl. welchii* was isolated in 48 per cent., *Cl. septicum* in 15 per cent. and *Cl. novyi* in 11 per cent. of cases, and from the beaks of captured crows they isolated *Cl. welchii* in 100 per cent., *Cl. septicum* in 2·8 per cent. and *Cl. novyi* in 18 per cent. of cases.

For many years considerable losses were experienced in horses from " forage poisoning " and in cows from " impaction paralysis." Gilruth (1913) was the first to show that " forage poisoning " of horses was definitely associated with certain samples of fodder and that the same fodder produced " impaction paralysis " in cows. The ætiology of the disease remained obscure until the suggestion was made by Buckley and Shippen (1917) in U.S.A. that the disease was probably botulism. This was later shown to be correct by Graham, Brueckner and Pontius (1917) and others in U.S.A. Bull (1921) showed that the disease in horses in Australia was a form of botulism and in all subsequent work found *Cl. botulinum* Type C to be the only type associated with the disease in South Australia, although Type D was isolated on one occasion from the soil. Botulism in horses has been found always to be associated with fodder, although the presence in the fodder of mouse carrion cannot always be excluded. Frequently the fodder is damaged by moulds and bacteria and the occurrence of the disease following ingestion of damaged and sprouting grain is of interest. Seddon (1922) obtained a culture of *Cl. botulinum* Type C (*B. parabotulinus*) from a bone of a cow dead of the disease

in Tasmania. He experimentally produced the disease in cows and horses and showed the association of the disease in cows with the ingestion of carrion.

Seddon and Carne (1927) recorded botulism in sheep due to the ingestion of rabbit carrion in New South Wales. Subsequently Bennetts (1928, 1933) found that botulism (toxic paralysis) was common in sheep in Western Australia. Rose and Edgar (1930) in New South Wales recorded another outbreak in sheep associated with rabbit carrion. We had seen one outbreak in South Australia in rams fed upon chaff which contained *Cl. botulinum* Type C and which had also caused the death of horses and cows. Bennetts (personal communication) has found Type C to be the predominating type in Western Australia although Type D has been isolated on occasion. In 1935 we prepared a formol-toxoid vaccine (Type C) containing 0·6 per cent. of potash alum, which was used in the field in Western Australia for prophylactic inoculation. The inoculations were carried out by J. F. Filmer, Senior Veterinary Officer of the Department of Agriculture of Western Australia, who informs us that 1,822 sheep were inoculated on 18 different farms while 5,083 uninoculated sheep served as controls. On 6 of the farms no deaths occurred in either group, while on 12 of the farms 205 of 3,432 uninoculated sheep died giving a death rate of 6 per cent. and 10 of 1,249 inoculated sheep died giving a death rate of 0·8 per cent. In the following season, 1936-37, the same type of vaccine was prepared by a commercial organisation and used under controlled conditions. No deaths occurred in 19,039 inoculated sheep, while 57 deaths (0·7 per cent.) occurred in 8,080 uninoculated sheep. In uncontrolled tests 2 deaths occurred in 34,582 inoculated animals. In previous years the incidence of the disease had been from 10 to 13 per cent.* Although the incidence had dropped very considerably during the 1936-37 season on account of the scarcity of rabbit carrion, there appears to be ample evidence of the value of prophylactic vaccination.

Although in Australia *Cl. botulinum* Type C is predominantly the cause of botulism in stock, ducks (Pullar, 1933) and wild birds (Pullar, 1934), Type B has been found by Seddon (1925) in silage which caused death in horses and cows, by Seddon and Carne (1927) in rabbit carrion and by Edgar (1929*a*) in silage. Rose and Edgar (1930) found Type B in rabbit carrion associated with deaths in sheep. Seddon and Edgar (1930) found *Cl. botulinum* in 7 per cent. of soils examined but made no mention of the types.

References.

Albiston, H. E. (1927). *Aust. J. Exp. Biol. Med. Sc.*, **4**, 113.
——. (1937). *Aust. Vet. J. In the press.*
Bennetts, H. W. (1928). *Aust. Vet. J.*, **4**, 105.
——. (1930). *Aust. Vet. J.*, **6**, 153.

* We are indebted to the Department of Agriculture, Western Australia, for this information.

Bennetts, H. W. (1931). *J. Dept. Agric. West. Australia*, **8,** 210.
——. (1932). *Council Sc. Ind. Res., Commonwealth Aust. Bull.* 57.
——. (1933). *J. Council Sc. Ind. Res., Commonwealth Aust.*, **6,** 137.
Belschner, H. G. (1925). *Aust. Vet. J.*, **1,** 108.
——. (1930). *Ibid.*, **6,** 68.
Buckley, J. S., and Shippen, L. P. (1917). *J. Amer. Vet. Med. Ass.*, **3,** 809.
Bull, L. B. (1921). *J. Dept. Agric. Sth. Aus.*, **25,** 403.
——. (1926). *Rept. Australas. Ass. Adv. Sc.*, **17,** 715.
——. (1928). *J. Dept. Agric. Sth. Aus.*, **31,** 968.
——. (1929). *Aust. Vet. J.*, **5,** 54.
——. (1935). *J. Comp. Path. & Ther.*, **48,** 21.
Dodd, S. (1918). *J. Comp. Path. & Ther.*, **31,** 1.
——. (1921). *Ibid.*, **34,** 1.
——. (1927). *J. & Proc. Roy. Soc., N.S.W.*, **61,** 135.
Edgar, G. (1929*a*). *Vet. Res. Rept., Dept. Agric., N.S.W.*, No. 4.
——. (1929*b*). *Ibid.*, No. 5.
——. (1931). *Aust. Vet. J.*, **7,** 64.
Graham, R., Brueckner, A. L., and Pontius, R. L. (1917). *J. Amer. Vet. Med. Ass.*, **6,** 161.
Gilruth, J. A. G. (1910). *Vet. J.*, **66,** 254 & 355.
——. (1912). *Proc. Australas. Ass. Adv. Sc.*, **13,** 567.
——. (1913). *Proc. Roy. Soc. Victoria*, **25,** 201.
Kneebone, S. J. (1925). *Aust. Vet. J.*, **1,** 66.
Oxer D. T. (1932*a*). *J. Council Sc. Ind. Res., Commonwealth Aust.*, **5,** 25.
——. (1932*b*). *Council Sc. Ind. Res., Commonwealth Aust., Bull.* 35.
——. (1936). *Aust. Vet. J.*, **12,** 54.
Oxer D. T., Adey, C. W., and Kennedy, M. (1936). *Ibid.*, **12,** 221.
——. (1937). *Ibid.*, **13,** 3.
Pullar, E. M. (1933). *Ibid.*, **9,** 26.
——. (1934). *Ibid.*, **10,** 128.
Rose, A. L., and Edgar, G. (1930). *Aust. Vet. J.*, **6,** 128.
—— ——. (1936). *Ibid.*, **12,** 212.
Seddon, H. R. (1922). *J. Comp. Path. & Ther.*, **35,** 147.
——. (1925). *Aus. Vet. J.*, **1,** 59.
Seddon, H. R., and Carne, H. R. (1926). *Vet. Res. Rept., Dept. Agric., N.S.W.*, No. 2.
—— ——. (1927). *Ibid.*, No. 3.
Seddon, H. R., and Edgar, G. (1930). *Aust. Vet. J.*, **6,** 98.
Seddon, H. R., Belschner, H. G., and Edgar, G. (1931). *Aust. Vet. J.*, **7,** 2.
Turner, A. W. (1928). *Ann. Inst. Pasteur*, **42,** 211.
——. (1930). *Council Sc. Ind. Res., Commonwealth Aust., Bull.* 46.
——. (1935). (With J. P. Scott and L. R. Vawter). *Proc. 12th Internat. Vet. Congress*, 168.
Wilsdon, A. J. (1934). *Rept. Dir. Inst. Anim. Path., Cambridge*, No. 3.

A SHORT REVIEW OF SUCCESSFUL PROGRESS IN ERADICATION OF CONTAGIOUS BOVINE ABORTION IN PALESTINE

By S. J. Gilbert,
Late Senior Veterinary Pathologist, Department of Agriculture, Palestine.

In the early days of the Mandate, contagious bovine abortion or bovine brucellosis did not exist in Palestine as far as could be ascertained. In view, however, of the rapid growth of Jewish settlement and the commencement of importation of Jewish cattle, its introduction was regarded as an almost inevitable sequence. It was consequently made compulsory for importers of European dairy cattle to obtain certificates of testing prior to shipment. Quarantine premises were primitive at that time, and it was obvious that cattle which had been in contact with positive cases would in time introduce infection even though re-tested on arrival.

By 1924, such infection had already appeared in some herds and work on blood testing was commenced at the Government Veterinary Laboratory in Jaffa. In the herds tested the percentage of infection was then small and eradication would have been comparatively simple but the settlers were vigorously opposed to disposal by sale or slaughter or, indeed, any form of control. As control measures would be unsuccessful without the co-operation of the settlers further testing of these herds was abandoned. Isolation of the infected herds could not be enforced. The available statistics in regard to the results of the use of vaccine were not considered sufficiently promising to urge or even permit of its use in view of the fact that the disease was of recent introduction and not widespread.

In one of the herds (at an Agricultural School) testing was continued and a new clean herd was slowly built up from negative calves.

In 1929, a fresh series of herd tests showed that the disease had spread very considerably and in one settlement was so severe that they were faced with ruin. These settlers were now prepared to agree to any control measures in order to rid their cattle of the disease and regular testing was commenced under a signed eradication agreement. A prevention plan or agreement was also drawn up for use with appropriate herds. The positive cases in the herd now under mention were more than 50 per cent. of the total number of cattle, and these were isolated and gradually disposed of. This settlement has now had a negative herd only for more than four years.

From that date the numbers of herds which have been accepted for control has steadily grown, as shown in the following table :—

Year.	*Herds.*	*Year.*	*Herds.*
1930 ..	18	1934 ..	64
1931 ..	43	1935 ..	89
1932 ..	54	1936 ..	109
1933 ..	57	1937 ..	116

Although the importation of European cattle for dairy purposes has continuously increased, the numbers of dairy cattle brought under control has also risen and is now approximately 65 per cent. of the total. Of these, some 90 per cent. are maintained free from contagious abortion.

There is every indication that this percentage will continue to rise and that it may, by general agreement, be possible to compel owners to dispose of infected animals by slaughter in the not very distant future. This measure is applied to animals newly imported and found positive on arrival in spite of the necessary certificates which accompany them.

Apart from the tests made under agreement for which no charge is made, a large demand has arisen for the testing of cattle which various owners of small herds desire to purchase. A fee is charged in these cases.

Cows which have actually aborted are tested free of charge providing the abortion has occurred on a farm or in an area in which contagious abortion has not previously been known to exist.

In all controlled herds the bloods are collected by Government Veterinary Officers who compile and forward test record sheets whenever collection is made.

The Laboratory Procedure.

This may be separated into the following sections :—

(*a*) Receipt and return of bottles for blood collection.

(*b*) Checking of test sheets with previous records.

(*c*) Filing of test records of each herd and arranging herds to be tested and dates of collection for the ensuing month.

(*d*) Arrangement of intervals between tests according to results of testing.

(*e*) Testing.

(*f*) Scrutiny of tests and in the case of partial or suspicious reactions decision as to retests and complement fixation tests when considered necessary.

(*g*) Special records of partial or suspicious reactions for examination at subsequent test.

The test itself follows very closely the agglutination test used by Sir John M'Fadyean and described by him in examples he has published of eradication of bovine brucellosis from dairy herds. The emulsion is a heavy one, the final mixture of serum, saline and emulsion being equal to a 1 : 6,400 suspension of barium sulphate.

In deciding the lowest titre which could be accepted as indicating a positive reaction under Palestine conditions there has been a great advantage in the fact that most of the herds have for a long time been negative and it would at once become evident were the titre too low, as partial reactions in obviously negative herds would become too numerous. All such reactions are of course followed closely to their conclusion. For some time the titre was lowered to 1 : 20 but it was found that partial reactions were somewhat excessive, especially in

hot weather. A few exceptional reactions have occurred and will be referred to later.

The complement fixation test has been regularly used as a check test and is of considerable value in diminishing the number of partial reactions to be regarded as suspicious, but should be so adapted as to give an equivalent reaction to the titre adopted as positive by the agglutination test.

Single tube tests at 1 : 25 are now carried out on all herds which have had no positives in the preceding 2 months. This has proved quite satisfactory and has effected a great saving of time and material. Slightly larger test tubes are used which permit of the single dilution being made in the tube used for the test. Complete or partial reactions are retested in series of four.

Although complete agglutination in a dilution of 1 : 25 is the standard positive titre every case of low titre is judged also on the previous test records.

Some examples of exceptional or anomalous results have been observed as follows. In two separate herds which were negative and had always been negative, one cow in each case suddenly showed a titre of complete agglutination at 1 : 50. In these cases the reaction to complement fixation was very slight and the cows were retained in the respective herds. These titres persisted for some 12 months and then became negative. No reactions have ever been observed in any other cows of this herd. On another occasion three Turkish cattle (Boaz breed) were imported from Turkey for use at the Government Stud Farm. These cattle gave reactions up to 1 : 50 to the agglutination test and reacted correspondingly to the complement fixation test. It was decided to keep them in isolation for further testing and during a period of some 6 months fluctuating reactions of this type were observed, after which the animals became negative. The cattle were returned to the herd some time before they showed negative reactions but no spread of brucellosis was observed.

As these reactions represent a very minute proportion of the total number of tests made it would be quite unpractical to alter the titre adopted as positive on their account and to do so would cause many positives to be missed. It has been our experience that suspicious reactors in herds in which infection exists, usually prove positive, whilst similar reactions in negative herds prove negative. Outbreaks appearing in negative herds have always been observed as strong reactions when discovered. The removal of reactors checks further spread, providing actual abortion has not taken place, and such occurrence has been rare.

The farming community in Palestine would not now consider any other method of dealing with contagious bovine abortion and the foregoing results have been achieved within comparatively few years and in the face of much financial stringency.

ABORTUS FEVER: SOME NOTES FROM SOUTHERN RHODESIA

Treatment of a Human Case with Prosepticine.

By Ll. E. W. Bevan, m.r.c.v.s.,
The Trypanosomiasis Bureau, Salisbury, Southern Rhodesia.

Bovine infectious abortion is said to have existed in Southern Rhodesia even before the advent of the white man in 1892, but the evidence advanced is based upon the statements of natives whose powers of diagnosis cannot be relied upon. It was not until 1913 that the writer, by the application of the agglutination test, proved the presence of specific abortion in two herds, one of which had recently arrived from Northern Rhodesia. The strains of organism used in the tests were derived from Sir John M'Fadyean at the Pathological Laboratory of the Royal Veterinary College, London; from the Nairobi Laboratory, British East Africa; and from the Onderstepoort Laboratory, Union of South Africa. The reactions with the different strains corresponded, indicating that the specific contagious abortion of these countries, namely Great Britain, Kenya, the Union of South Africa, Northern and Southern Rhodesia, were closely related. Samples of the bloods were sent to Sir John M'Fadyean, who was able to confirm the diagnosis. These facts were recorded in this journal of June 30th, 1915.

In those days transport in Southern Rhodesia was primitive and extremely slow, and it often happened that blood sent to the laboratory in Salisbury for the agglutination test arrived decomposed and putrid. The writer therefore devised a pipette, resembling the Wright capsule, containing a special solution which preserved the blood without interfering with its agglutinating titre. This rendered it possible for the stockman or farmer at a distance to send samples of blood to the laboratory for the test. The method was described in this journal and is used by the Veterinary Research Department of the Colony even to-day. Incidentally it proved of considerable value to the Veterinary Department in that owners of infected cattle by forwarding samples thereby revealed the fact. A modification of this method known as the "Abortoscope" was introduced, by means of which the owners themselves could test their cattle with accuracy. This was useful where regular monthly tests of dairy cattle were recommended, or dairymen desired to "buy in" cows for their herds.

It may be mentioned that the disease was at one time included in the Schedule of Infectious Diseases and the attempt was made to control it. This was extremely difficult in view of the fact that owners failed to report, fearing quarantine and knowing that no specific remedy was available. The detection of the disease was one thing but its effective control under the conditions obtaining in this country,

another. Eventually, in despair, the disease was removed from the list of Scheduled Diseases, but it remained as a disease under the Public Health Act and its control was relegated to the Medical Department but was seldom if ever attempted. This appeared to the writer to be a retrograde step and an admission of ignorance on the part of the veterinary profession. To obviate this difficulty—a difficulty which is not peculiar to Southern Rhodesia—the writer experimented with various dead vaccines, the live vaccine being too dangerous to apply under local conditions. He found that several of the co-called " dead " vaccines gave rise to agglutinins in the inoculated animal : but, apparently, agglutinins are not synonymous with immunity although often an indication of it. Finally he introduced a vaccine prepared from massive cultures of *Br. abortus* attenuated by exposure to chloroform. This was applied in over one hundred outbreaks and in some instances with most favourable results, but in others the results were not so satisfactory. Whether the good results were due to the vaccine or to a natural " wearing out " process is uncertain, but it is remarkable that the cessation of abortions so frequently followed the application of the vaccine. Of course, the vaccine could not restore life to a dead fœtus and the abortion of a dead calf after the application of it was often unfairly attributed to it. Another possible reason for its failure was a concomitant infection with infectious vaginitis which was very prevalent throughout the country. Also, it would now appear, sufficient care was not taken to ensure that the cultures from which the vaccines were prepared were " rough " or " smooth," a factor upon which their antigenic properties are said to depend.

In 1916, Dr. Alice C. Evans drew attention to the resemblance between the organisms of contagious abortion of cattle and undulant or Malta fever of man. The importance of this observation was immediately recognised in this country where mysterious cases of undulant fever were occurring although no possible association with goats could be traced. The writer was struck by the fact that many of these cases were from farms where bovine abortion existed, and on November 12th, 1921, he presented a paper to a combined meeting of the Southern Rhodesia Veterinary Association and the British Medical Association, in Salisbury, entitled " Infectious Abortion of Cattle and its possible relation to human health," in which he suggested that these cases of so-called undulant fever were suffering from an infection caused by *Br. abortus* of cattle. This subsequently proved to be correct. He also said in his paper, " If infectious abortion of cattle is essentially a bovine disease, a grave responsibility attaches to the Veterinary Department : and if this disease is communicable to man, a hearty co-operation between the medical and veterinary profession is necessary in dealing with it "—a practical application of comparative pathology.

In a table of 35 cases of this nature compiled by the Medical Department during the period 1921-25, 15 of them were known to

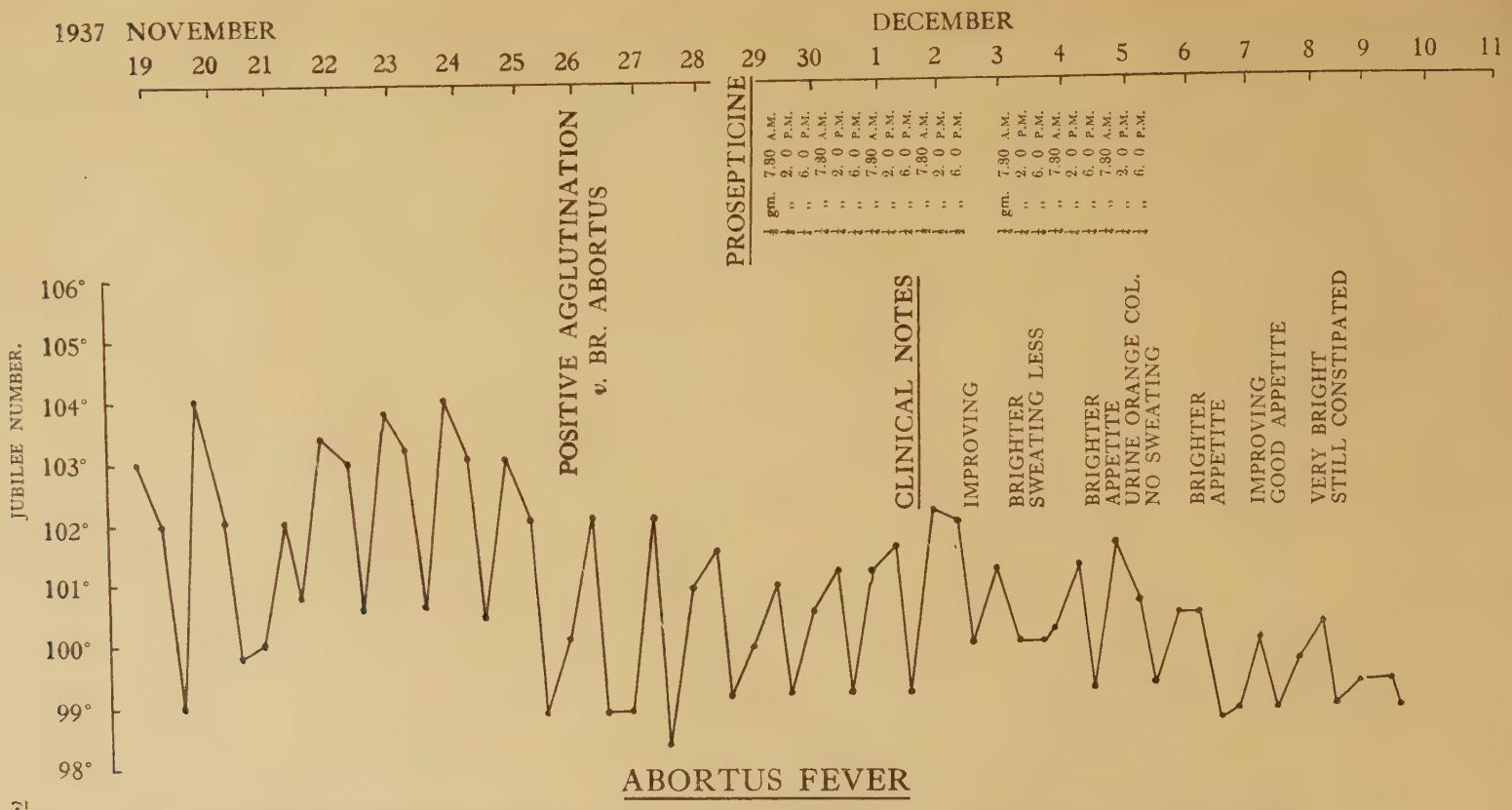
the writer to have come from areas where infectious abortion of cattle existed, or to have consumed dairy products from infected herds. During the following years as many as 200 such cases were recorded —the actual number must have been far greater—but recently the number has markedly declined and at present cases are rare. Possibly the population is becoming immune, for abortion of cattle is as prevalent as hitherto. The publication of the above paper in the *Transactions of the Royal Society of Tropical Medicine and Hygiene*, January 19th, 1922, and of another paper read before the Sections of Tropical Medicine and Comparative Medicine of the Royal Society of Medicine, March 12th, 1925, gave rise to considerable criticism, but it has since been found that *Brucella abortus* of cattle does, in circumstances which are not even yet precisely understood, occasionally infect man in most parts of the world. But in view of the prevalence of *abortus* infection of cattle and swine it is remarkable that human cases are so rare. For example, in Great Britain where probably one-third of the cows are infected with the disease, and the milk is frequently contaminated, cases are rarely detected. It is admitted that in man the clinical symptoms are so little characteristic that the disease may be wrongly diagnosed as influenza, tuberculosis, enteric fever, rheumatism, malaria or some other condition. The disease has, however, been detected in Denmark, the United States of America, Canada, Sweden, Poland, Switzerland, Holland and many other countries where infectious abortion occurs. It is commoner in males than females, and most often attacks those between the ages of 15 and 45. It is very uncommon in children under 5 years of age. To account for this very curious incidence of the disease the writer, when attending the National Veterinary Medical Association Conference at Folkestone in 1932, hazarded the suggestion that children, by frequently imbibing infected milk might contract the disease in a sub-acute form and thereby derive some degree of resistance. Later, at a meeting of the London Medical Society, he repeated this suggestion and drew attention to the fact that Sven Wall had reported to the Fifth Scandinavian Pathological Congress at Lund, 1932, that in the herds where the calves lived together with the infected cows and were fed upon their milk, the disease in the course of years became less severe in the young animals than in those herds with special stalls containing the infected cows, and where the calves were fed on sterilised milk.

In view of the writer's long association with this problem, it is a somewhat remarkable coincidence that he is now able to record in some detail a case of abortus fever in a child of 5½ years, his own daughter, who recently contracted the disease, and it is hoped, is now recovering from a severe infection, the course of which has been carefully observed.

The subject, Catherine Mary, was born at Chertsey, in Surrey, on July 9th, 1932, and remained in England until March, 1934. During that period, she received no cow's milk, it being impossible to obtain milk

free from the suspicion of tuberculosis and contagious abortion. She was, therefore, brought up on "Cow and Gate" and grew into a fine, well-developed baby. On her return to Rhodesia, she was given unboiled milk from a dairy where every possible care was taken to ensure the cleanliness of the milk. Some 6 months ago, however, this dairy was removed into the country and milk had to be obtained from another source. In August last, the child contracted measles somewhat severely, and during that period received unboiled milk from the new dairy. Her elder sister contracted measles from her and also received the milk throughout. During the illness of the sister, Catherine, who was recovering, could not be given whole-time attention, but it was soon realised that she did not improve as rapidly as was expected. She was weak and easily tired, and complained of a pain in the left groin. Later, this pain disappeared from the groin, but developed behind the knee, ankles and elbow, and the child became lame and unable to run. Her lassitude increased and at last she became so weak that she had to be kept in bed. Here she suffered from severe sweats, especially in the afternoons, but these were at first attributed to the extremely hot weather. From time to time she complained of a slight sore throat. From day to day she became weaker and rapidly "faded away." Her complexion, previously that of a healthy English child, became putty-coloured, although her lips and conjunctivæ did not indicate anæmia. Throughout, she was obstinately constipated and her urine was thick with phosphates. Dr. P—— was called in and was at a loss to diagnose the cause of the complaint. He suspected *B. coli* infection of the kidneys but on examination of the urine by the Public Health Laboratory, no bacteria, albumen, sugar or acetone could be found: indeed, a report of "normal" was returned. In desperation, the writer, on November 27th, when the child appeared in danger of passing away, tested her blood by means of the Abortoscope and almost immediately obtained a positive reaction. Control bloods from himself and her sister were negative, and the latter has remained in excellent health throughout. Apparently she had not become infected from the milk, or by constant attention on her sister. There being no recognised specific treatment for this disease, it was decided to try the effects of prosepticine which, according to recent literature, is as effective against hæmolytic streptococci as prontosil, but less toxic. As the administration of this drug was left to the writer, he could only summon up courage to apply it at first in small doses of $\frac{1}{8}$ gramme, three times a day, but as no ill-effects were noticed, and the patient showed marked improvement, he became bolder and gradually increased the dose to $\frac{1}{2}$ gramme three times a day. The dosage and quantity administered are shown in the chart. From the second day, when the child had received only $1\frac{1}{4}$ grammes of prosepticine, an improvement was noticed in her clinical condition, and from day to day the improvement increased. The afternoon elevation of temperature and weakening sweats gradually became less and after the 4th day the latter only occasionally occurred. Appetite returned, the patient became cheerful, the temperature, although still slightly irregular, showed no marked elevations. But for a persistent constipation which did not yield to the mild purgatives which only could be administered, the patient appeared to be on the road to recovery.

Some comments on the above case may be permitted. The history is given in some detail to indicate that no opportunity had occurred for the child to derive immunity by the previous imbibing of infected milk. It is believed that the infection took place during



ABORTUS FEVER

CHART SHOWING TEMPERATURE OF C.M.B. BEFORE AND AFTER "PROSEPTICINE"

or after the measles when her natural resistance was lowered. The elder sister was a stronger child and her recovery from measles was more rapid.

The characteristic features of the sickness were the afternoon elevations of temperature and severe sweating, the resulting constipation, fleeting pains in the joints, the putty-coloured complexion, extreme weakness and rapid emaciation. The selection of prosepticine* was not entirely a " shot in the dark." It was based upon the known specificity of the drug for the streptococci and the fact that the Brucellæ were at one time regarded as micrococci. The rapid recovery of one case cannot be attributed with certainty to the drug : it may have been due to natural causes : but previous cases observed in this country have persisted for many months and in most cases recovery has only occurred following a change of climate. In this case recovery appeared to synchronise with the administration of the drug.

With regard to the source of infection. On enquiry, the dairyman admitted that shortly after he commenced to supply the milk a series of abortions occurred in his herd, and that on testing twelve selected cows the Veterinary Research Department had detected ten to be infected. These observations appear to afford an explanation of some of the mysteries associated with abortus fever, referred to earlier in this article.

In presenting these notes the writer desires most gratefully to acknowledge the influence of his great master, Sir John M'Fadyean, whose teaching inspired these investigations and whose encouragement maintained them. And this being the Jubilee issue of his journal, he would wish to record the valuable assistance always obtained from its so carefully edited columns. In an inaugural address to the students of the Royal Veterinary College, Sir John once urged them to endeavour to leave their heritage richer than they found it. He might well have invited them to strive to follow his noble example.

References.

Report of the Departmental Committee appointed by the Board of Agriculture and Fisheries to enquire into Epizootic Abortion. (1905.) Part I.

M'Fadyean, J., and Stockman, S. (1909). Epizootic Abortion in Cattle. Appendix to Part I of above Report.

Bevan, Ll. E. W. (1915). Contagious Abortion in Cattle in Rhodesia. *J. Comp. Path. & Ther.*, **28**, 97.

——. (1915). A simple method of obtaining serum for the agglutination test from cattle suspected to be suffering from Contagious Abortion. *Ibid.* 277.

*After the despatch to us from S. Rhodesia, on December 11th, 1937, of Mr. Bevan's paper, our attention has been drawn [*Lancet*, 2 (Dec. 11) 1385, Annotation] to the report of another successful treatment of a human patient with compounds of the sulphanilamide group [Béthoux, L., Gourdon, E., and Rochedix, J., *Bull Soc. méd. Hôp. Paris*, Nov. 15th, 1937, p. 1297. Several cases of recovery after similar treatment have subsequently been recorded.]—*Ed.*

Bevan, Ll. E. W. (1925). The Abortoscope. A simple apparatus for the detection of Infectious Abortion of Cattle. *Vet. J.*, **81**, 476.

Ross, G. R. (1927-28). The Agglutination Test in Undulant Fever due to *Brucella abortus*. A Preliminary Note on the value of the "Abortoscope." *Trans. Roy. Soc. Trop. Med. & Hyg.*, **57**.

Evans, Alice C. (1918). Further studies on *Bacterium abortus* and related bacteria. II. A comparison of *Bacterium abortus* with *Bacterium bronchisepticus* and with the organism which causes Malta Fever. *J. Infect. Dis.*, **22**, 580.

Bevan, Ll. E. W. (1921-22). Infectious Abortion of Cattle and its possible Revelation to Human Health. *Trans. Roy. Soc. Trop. Med. & Hyg.*, **15**, 215.

——. (1931). The Correlation between Infectious Abortion of Cattle and Undulant Fever of Man. *Vet. Rec.*, **18**, 547.

Smith, A. (1937). Chemotherapy of Streptococcal Infections. *Lancet*, **2**, 1064.

In a letter dated 5th January, 1928, Mr. Bevan gives further notes on the above case. On 24th December, the patient suffered a relapse and was administered 4 grammes of the drug, but this seemed to affect her heart and breathing, and so the treatment was not pressed further. The patient became "bloodless" and appeared to "fade away."

THE SUSCEPTIBILITY OF THE WILD RAT TO INFECTION WITH *BRUCELLA ABORTUS*: A PRELIMINARY NOTE

By T. J. Bosworth,
Institute of Animal Pathology, University of Cambridge.

The control of contagious abortion in cattle is a problem engaging official attention in many parts of the world; until a reliable curative agent is found, the success of any measures adopted depends almost entirely on their efficiency in preventing the spread of infection from animal to animal or from one herd to another. The difficulties which may arise are sufficiently formidable to restrain undue optimism in all but the inexperienced: they usually result from causes which are fully understood. Occasionally, however, the manner of spread of the disease remains obscure in spite of the fullest investigation into all the circumstances. This has suggested enquiry into whether or not small animals such as vermin are likely to carry infection. It was decided, therefore, to attempt to infect the wild rat with *Br. abortus*; then, if a positive result was obtained, the course of infection and the possibility of the animal acting as a transmitting agent, in which capacity it might act in view of its well-known habits, were to be examined. Shortly after the work had begun and before any results had been obtained the writer's attention was drawn to an article by Karkadinovsky (1936) reporting the isolation of *Br. abortus* from rats on farms in Russia where cattle were infected. It was thus evident that the subject was sufficiently important to warrant investigation.

Experimental.

Effect of Feeding Rats with Infected Animal Tissue.

Rats were caught in cage traps or by other means on premises believed to be free from infection and were transferred to metal cages of the Topley pattern. Each was fed with infected material in the form of a suspension of the ground-up spleen of an infected guinea-pig mixed with the food either on one day or on successive days. The strain of Brucella used was passed directly from an aborted fœtus to the guinea-pigs whose spleens were used for feeding and it appeared to be fully virulent for the guinea-pigs. Except in a few early cases in which attempts to obtain blood were unsuccessful every rat used in this investigation was tested for *Br. abortus* agglutinins before it was exposed to infection, but in none was a reaction observed in serum dilutions of 1 : 10 and upwards. The blood was obtained under anæsthesia from an incision in the tail. After exposure to infection the rats were tested again at intervals and then killed and examined for *Br. abortus* in their tissues by cultural methods and/or guinea-pig inoculation.

Many of the rats contracted infection but showed no obvious disturbance of health. The following table gives the results obtained with the first twelve that were fed on infected spleen :—

Rat.	Agglutinins in Serum.			Killed after Interval of, Days.	Result.	
	Before Exposure, Titre.	After Exposure, Days.	Titre.		Cultural Examination.	Guinea-pig Test.
1	0	21	80	36	Spleen +	...
		36	40			
2	...	21	0	57	—	—
		57	20			
3	0	21	0	57	—	...
		57	0			
4	...	21	40	46	Spleen, liver and epididymis +	+
		46	40			
5	...	21	0	42	—	—
		42	0			
6	...	21	0	47	—	—
		47	0			
7	...	21	20	47	Spleen, pharyngeal and mesenteric glands +	+
		47	40			
8	0	21	0	45	—	—
		45	0			
9	0	23	80	23	Heart blood, spleen and liver +	...
10	0	21	0	42	—	—
		42	0			
11	0	21	40	39	Spleen and kidney +	+
		39	80			
12	0	21	20	36	—	—
		36	10			

+ = Positive. — = Negative. ... = Not done.

Five of the rats thus showed definite infection at the time of *post-mortem* examination and two others had a low agglutinin titre indicating that infection, probably of a transitory nature, had occurred. Subsequent observations made on nine other animals, as they became available, have confirmed these results in that six of them contracted infection when fed in the manner described above.

Course of Infection in the Rat.

As already mentioned the wild rat appears to suffer no ill effects as the result of ingesting *Br. abortus*. It was also found not to be

obviously affected by the intraperitoneal injection of relatively large doses of culture, containing up to 5×10^7 living organisms. Moreover, with the exception of some degree of splenic enlargement which, however, was not sufficiently definite to be of significance in diagnosis, gross lesions were absent in animals killed at varying intervals after injection. It is true that *Br. abortus* was recovered from a purulent focus in the epididymis of one of the rats that had been infected by ingestion, but as it was not the only organism present in the pus there was some doubt as to its being the cause of the visible lesion in spite of the known tendency for it to settle in this situation in other species of animals. It seems, therefore, as far as one can judge by working with a single strain of *Br. abortus*, that the wild rat is much more resistant than the white variety, in which intraperitoneal injection is apt to be followed, depending on the dose, by either death within a few days or a protracted illness leading to a fatal issue after the development of widespread purulent lesions in the abdominal organs and the lungs (Ber, 1936).

In the case of rats infected by ingestion the organism was recovered from the lymph glands of the alimentary tract and from the heart blood, spleen and liver. This suggested its distribution by the lymph stream and later in the circulating blood, whilst its presence in the kidney and epididymis indicated the channels through which it might be excreted from the body. Cultures were isolated from the spleen more regularly than from other situations but an abundant growth was seldom obtained even from that organ and then only when the interval after infection was relatively short. In fact some of the rats showed a tendency to eliminate *Br. abortus* from their tissues fairly rapidly: this was illustrated by several cases in which there was a gradual decline to 1 in 10 or less in the agglutination titre from the 3rd week onwards and complete disappearance of the organism from the body by the end of the 6th week, when it could no longer be demonstrated by cultural or inoculation tests. Not all of them, however, overcame the infection in so short a time. In one case it was still in existence after 14 weeks but the maximum period over which it may persist has not been ascertained. Agglutinins were demonstrated in the blood of all but one of the affected animals. They occurred in low titre (1 : 20 to 1 : 80) where infection was by feeding, and occasionally up to 1 : 320 after the injection of a large dose of culture.

Excretion of the Organism.

The isolation of *Br. abortus* from the kidneys of one rat and from a lesion in the epididymis of another suggested that it might be passed out of the body by way of the urino-genital tract. Attempts were therefore made to demonstrate the organism in the urine of affected rats. The fæces were also examined. In the first instance composite samples of these excreta were made into a suspension and inoculated into guinea-pigs, and in this way a positive result was obtained from

one out of seven rats. Subsequently the fæces and urine of ten other rats were examined separately and *Br. abortus* was found in the urine of one of them but not in any of their fæces. It has thus been possible to demonstrate one way in which the foodstuffs and surroundings of other animals may be contaminated by infected rats.

Transmission of Infection from Rat to Rat.

Among rats kept together in the same cage infection can be shown to pass from one individual to another. This happened on three of the eight occasions on which the experiment was attempted. The fact that rats kept in captivity are apt to attack each other, even when they belong to opposite sexes, prevented a larger series of observations from being made. The details of the eight attempts are as follows :—

(1) Rat 4 which had been fed on infected guinea-pig spleen and showed an agglutinin titre of 1 : 40 was transferred to a clean cage on 24.10.36 in contact with a normal rat, No. 15. It was killed accidentally 25 days later. *Br. abortus* was recovered from the spleen, liver and epididymis. Its fellow did not develop agglutinins and showed no evidence of infection at *post-mortem* examination on 28.11.36.

(2) Rat 7, infected as above, was placed in a clean cage with normal Rat 19 for a period of 26 days when both were killed for examination. No. 7 had an agglutinin titre of 1 : 40 and yielded cultures of *Br. abortus* from the spleen and lymphatic glands. No. 19 showed no agglutinins and direct cultures were negative but the organism was isolated from two of four guinea-pigs inoculated with a suspension of its spleen and liver.

(3) Rat 11, infected as above, was placed in contact with Rat 23. The latter died after 18 days and showed no evidence of infection. No. 11 had a titre of 1 : 80 and gave positive cultures from spleen and kidney.

(4) Rat 14, infected as above, was in contact with Rat 20 for 34 days, when the latter showed an agglutinin titre of 1 : 20. *Br. abortus* was recovered from both animals *post mortem*.

(5, 6, 7 and 8) The rats used in the remaining four attempts were infected by intraperitoneal injection of a culture of *Br. abortus*. Each was then placed in contact with a normal rat which was tested for agglutinins at intervals during the next 6 weeks. One of the in-contact animals reacted and the organism was recovered from its tissues. Cultures from the other three were negative.

The results of this experiment show that rats may pass on infection to their fellows when housed in close contact with them. Transmission might have occurred in a higher proportion of cases if the period of observation had been extended but there seemed to be no point in prolonging observation as the conditions of the experiment were purely artificial and some positive results had been obtained.

Natural Infection in the Rat.

Karkadinovsky (1936) reported the isolation of *Br. abortus* from rats caught on farms where infection was prevalent among the cattle. In order to confirm this finding and to obtain some idea as to the

frequency of infection in these rodents, requests were made for them to be sent to the laboratory for examination. The response, however, has been disappointing, and only two batches have been received so far from badly infected premises, through the kind collaboration of the writer's colleague, Mr. F. Blakemore, but steps are being taken to obtain them in adequate numbers. At present it is possible to record only that *Br. abortus* was isolated from one of three animals comprising the second batch. The first batch, of over 40, were all negative. It is evidently desirable to collect as much information as possible regarding the incidence of infection among rats in this country so as to ascertain if they are of any importance as disseminating agents under natural conditions. The only contribution which has yet been made to the subject is that by Menton (1937) who found that 200 rats recently examined in Staffordshire were all free from *Br. abortus* agglutinins although many of them were caught on infected premises including a slaughter-house at which infected animals were killed.

Conclusions.

(1) The wild rat may become infected with *Br. abortus* by ingestion of contaminated food.

(2) Infection may pass from rat to rat when they are kept in close contact with one another.

(3) The urine of infected rats may contain the organism and thus be a source of contamination of the foodstuffs of other animals.

References.

Ber, A. (1936). *C. R. Soc. Biol.*, **122**, 845.
Karkadinovsky, J. A. (1936). *Ibid.*, **121**, 1611.
Menton, J. (1937.) *Brit. Med. J.* December 25th, 1273.

SOME PASSAGES FROM PROF. J. M'FADYEAN'S EARLIER WRITINGS ON TUBERCULOSIS.

" . . . We publish elsewhere a circular recently issued by the Board of Supervision giving the views of Dr. Littlejohn on this question. Many of the statements in that report well illustrate the errors into which medical officers of health almost invariably fall when they venture to discuss diseases of the lower animals. For example, the doctor says that ' there is one part of the animal which unmistakably points to the presence of the disease, and that is the udder.' It would puzzle Dr. Littlejohn to support this statement by the authority of any one who has specially studied the subject, and he certainly cannot on that point give a first-hand opinion that would carry any weight. So far as we are aware, the only systematic work that has been carried out in this country with a view to discovering what proportion of tuberculosis of the udder prevails in dairy stock is that the results of which were summarised in a paper read by Drs. Woodhead and M'Fadyean before the last meeting of the British Medical Association. These gentlemen in their examination of the Edinburgh dairies found that not more than 16 per cent. of the cases of mammitis were tubercular, and they found it quite impossible to distinguish between the tubercular and non-tubercular indurations except by the somewhat tedious process of staining for the micro-organisms present in the milk. Dr. Littlejohn further implies that emaciation is a great guide in diagnosis, and that the dairyman as soon as he detects the disease hurries the animal to the shambles. We fear that cowkeepers are not such experts at diagnosis as the doctor seems to think and it is quite certain that cows may have tubercle of the udder and continue in prime condition. . . ."—Editorial Article. Bovine Tuberculosis. This Journal, 1888, **1**, 147-148.

" . . . The first stage of those who turn their attention to the study of animal tuberculosis may almost be described as a condition of panic. If anyone will take the trouble to read much of what is being said and written on this subject, he cannot fail to observe that in many cases it is assumed that to prove the identity of human and animal tuberculosis is to prove that the latter must often be a source of infection to mankind. This, however, is a separate question, demanding for its proof quite a different train of evidence. Moreover, a survey of the almost innumerable recorded experiments bearing on the intercommunicability of the human and animal disease makes it plain that these experiments have, as was natural, been mainly directed towards proving the identity of the affection in the different species, and that the great bulk of them do not furnish any very reliable evidence regarding the second and perhaps more important question.

" At the Congress recently held in Paris for the study of tuberculosis in man and animals, one of the speakers summed up his conclusions by saying that ' The flesh of animals, having been experimentally recognised as virulent, and human phthisis coming frequently from the butcher's stall, all the flesh of tubercular animals ought to be suppressed, that being the only efficacious measure.' If this is not the language of exaggeration, it is at least a statement that is not yet warranted by either observation or experiment. . . ."—Editorial Article. The Connection between Human and Animal Tuberculosis. This Journal, 1888, **1**, 352-353.

" Since the date of the Congress (the British Congress on Tuberculosis) some too enthusiastic defenders of the view that the two diseases are distinct have brought a charge of misrepresentation against those who, in criticism of Professor Koch's present attitude, pointed out that Professor Koch himself was mainly responsible for the view generally held during recent years, namely, that human and bovine tuberculosis are identical diseases. Those who bring this charge appear to be under a double misapprehension. In the first place, no one has ever maintained that the two diseases were generally regarded as identical because Professor Koch had stated that such was his own opinion. There are no Popes in science, and the mere *ipse dixit* of one man, however eminent he may be, is not sufficient to upset convictions arrived at after an examination of the whole available evidence. What is meant when it is said that Professor Koch is mainly responsible for the generally accepted opinion that bovine and human tuberculosis are identical diseases is, that the published account of Professor Koch's own researches appeared to most people to compel that conclusion. The evidence lay in the new facts brought to light by Professor Koch's researches, and not in any degree in the conclusions which that disitinguished authority drew from these facts. . . ."—Editorial Article. Professor Koch's Past and Present Opinions regarding the relationship between Human and Bovine Tuberculosis. This Journal, 1901, **14**, 363-364.

PRESENT-DAY ADMINISTRATION OF THE MILK AND DAIRIES LEGISLATION AS INFLUENCED BY THE WORK AND TEACHINGS OF SIR JOHN M'FADYEAN

By D. S. Rabagliati, o.b.e., b.sc., f.r.c.v.s., d.v.s.m.,
Chief Veterinary Officer, West Riding, Yorkshire.

In these days of team work, when the work of one investigator or even group of investigators so largely influences the findings of others, it is often difficult to assess the true value of the researches of any one individual. In summing up the work of Sir John M'Fadyean the historian would not be able to place him as a purely veterinary public health worker as the term is understood to-day. Nevertheless, it is a truism to say that his researches, his teaching and his influence have all been instrumental in bringing about much of our legislation in preventive medicine and in stimulating the formation of the admirable Veterinary Departments of some of our towns and county councils as exist in certain districts at the present time.

In 1890, Robert Koch, described what he termed " a remedy which conferred on the animals experimented on an immunity against inoculation with the tubercle bacillus, and which arrests tuberculous disease." This remedy was in fact tuberculin, and Koch had hopes of utilising it as a cure for, or at least as a method of arresting the progress of, tuberculosis in man. M'Fadyean, in an editorial in the *Journal of Comparative Pathology and Therapeutics* published the same year wrote as follows : [1] " One point appears to be already abundantly verified, *viz.*, that the use of the fluid is capable of rendering most valuable service in diagnosis. Unfortunately, to the human practitioner this would be of very secondary importance, should its curative properties not stand the test of experience. It is hardly the same in the case of the veterinary surgeon. No doubt the discovery of a specific for tuberculosis of the domesticated animals would be of enormous value, but, even without that, the possession of an unfailing diagnostic test would place in the veterinary surgeon's hands a weapon with which he could practically root the bovine disease out of existence."

In the light of our present-day knowledge this view expressed at such an early stage is remarkable, and it must be most gratifying to Sir John to know that his forecast was so true and that the improvement of tuberculin has made such strides that tuberculin testing has now become one of the most important methods of eradicating such a distressing and dire malady as tuberculosis. So much is this the case that at the end of 1937 the Ministry of Agriculture and Fisheries has brought into being legislation preparatory to making a general raid on tuberculosis in cattle (and incidentally on certain other diseases), and the chief means of achieving one of the goals aimed at is to be an enormous increase in the use of the tuberculin test. Despite much criticism as to the tardiness of our legislation for the prevention

of disease, the fact remains that at the present time there are approximately 770 Attested herds in England and Wales, and 615 in Scotland. To this list must be added about 800 herds undergoing " assisted testing" so as soon to become " attested;" thus in a very short time we can count on having well over 2,000 herds from which tuberculosis has been completely eradicated. These numbers do not include the herds licensed for the production of " tuberculin tested milk " under the Milk (Special Designations) Orders of which there are also many hundreds. More satisfactory than these figures, however, is the fact that the numbers of these herds are increasing at a very rapid rate and the general outlook of the agricultural community is extremely favourable to the change that is slowly but surely taking place.

The first cattle to be tested with tuberculin in this country were two Ayrshire cows tested by M'Fadyean with the help of the late Sir Stewart Stockman and Professor Mettam, at the Edinburgh Veterinary College in 1891[2]. Both happened to be rather advanced cases of disease and in the case of the first cow six subcutaneous tests were given successively and the temperatures, respiration and pulse rates were recorded every 2 hours after each test. In the case of the second cow only three tests were carried out but similar records were taken and carefully noted. The first cow reacted typically to the test, but in the case of the second cow the temperature never reached 103° F. and thus the test was considered to be negative, although, as previously stated, the cow was suffering from advanced tuberculosis.

Commenting on his own experiments and on those of certain continental workers, M'Fadyean expressed some doubt as to the value of the test and wrote in a further editorial as follows : [3] " It is evident that the proportion of cases in which non-tuberculous animals react does not require to be large in order to deprive the agent of its whole diagnostic value, and unless that proportion should turn out to be smaller than it has been in the experiments hitherto made, Koch's fluid will not find a great sale even as an aid to diagnosis."

At the Seventh International Congress of Hygiene and Demography held in London in August, 1891, M'Fadyean, along with Dr. Sims Woodhead, read a paper on " The Transmission of Tuberculosis from Animals to Man by means of flesh and milk derived from Tuberculous Animals."[4] In connection with this they arrived at the following conclusions : first, that wherever the presence of a tuberculous condition of the udder could be demonstrated clinically, it would be little short of criminal to give the milk to delicate children ; and secondly, that there was great necessity for the thorough inspection of both dairy cattle and of animals that were slaughtered for food purposes, but it might be accepted that the danger of contracting tuberculosis from milk was greater than that of contracting it from meat.

To show the continued interest M'Fadyean took in veterinary public health, it may be mentioned that in 1892 he wrote two editorials in this journal, the one on " The Prevalence of Tubercu-

losis amongst cattle in Great Britain," and the second on " Tuberculosis Disease of Domestication " ; both of which had a direct bearing on the subject of this note. Again, in 1893, in an original article on " The Diagnosis of Tuberculosis in Cattle "[5], M'Fadyean discusses the results obtained from the use of tuberculin as a diagnostic agent and adds to the knowledge of that time the results of certain experiments he had carried out on 75 cattle. The net results were somewhat disappointing and rather at variance, for out of 36 cattle the temperatures of which rose to 103° F. or more, and were thus classified as reactors, tuberculous lesions could only be found in 30 and six were apparently free. Conversely, out of 39 animals in which the temperatures never reached 103° F. and were thus considered to be non-reactors, no less than 19 showed tuberculous lesions when killed and only 20 proved to be really free from the disease. Even in the light of this experiment M'Fadyean wrote : " In conclusion I have no hesitation in saying that, taking full account of its imperfections, tuberculin is the most valuable means of diagnosis in tuberculosis that we possess—without tuberculin even the sharpest and most experienced practitioner is powerless to detect tuberculosis in its early stages ; with it, he will find it possible to detect the majority of cases even when the lesions are very slight."

In the same year Sir John wrote another editorial on " The Etiology of Tuberculosis " and discussed a statement made by Jenson of the Veterinary School in Tokio regarding the prevalence of tuberculosis in Japan amongst the human population, although originally the native cattle were almost free from the disease. Later on, M'Fadyean was fortunate in being able to publish the result of a tuberculin test he had carried out on a herd of 23 cattle, when all had reacted to the test.[6] Fortunately, the owner being an enlightened man, allowed the whole herd to be slaughtered out and all were found to be affected with tuberculosis. To prove the correct interpretation given by the tuberculin, M'Fadyean was able to inject two other cattle with the same tuberculin. One of these, although in excellent condition, reacted and was found to be affected, while the second, although greatly emaciated, failed to react, but *post-mortem* examination failed to show the least trace of disease. In a further editorial in his journal later in 1893, M'Fadyean, writing on " The Prevention of Tuberculosis," made a point which is apparently only now beginning to soak into the minds of agriculturists, although it has been repeated on many occasions by members of the profession since M'Fadyean mentioned it. He wrote : " Now, far be it from us to deprecate the interest taken in this respect of tuberculosis of cattle, or to hint that a question touching the health of human beings can properly be compared with the one relating to the mere economic importance of a particular animal disease, but at the same time it is a matter for surprise that more attention is not being given, especially by cattle owners, to bovine tuberculosis, altogether apart from its bearing on human health." He ends this editorial with the following

words : " It is scarcely possible to doubt that tuberculin is destined to play a most important role in the future. Its discovery put into the hands of the veterinary profession the very weapon that was required to combat animal tuberculosis, and stock-owners, as soon as they become convinced of this will not be slow to call it into use."

Perhaps the most important part of M'Fadyean's work so far as the veterinary side of the Milk and Dairies legislation is concerned was the part he took in disproving the statement made by Robert Koch in 1901, when he (Koch) startled the scientific world by asserting that the bovine tubercle bacillus as found in lesions, discharges and secretions from affected cattle had little or no effect on mankind. In other words, Koch made it known as his opinion that the bovine type of tubercle bacillus played no part, or at the most such a negligible one as to be for all practical purposes ignored, in producing tuberculosis in the human race. In an excellent treatise published in 1901 M'Fadyean advocates the general inspection of milking cattle by veterinary surgeons and made the following criticism. " But at the same time we ought not to concede to the milkman the right to sell us tubercle bacilli, even if we are assured that —like Dr. Koch's experimental pigs—we had nothing to fear beyond the development of ' little nodules here and there in the lymphatic glands of our necks and a few grey tubercles in our lungs '." Again criticising Koch's theory of the non-intercommunicability of the organism he wrote : " Now with the utmost diffidence, I venture to submit that at least one of the premises contained in this argument (*i.e.*, Koch's) is not well founded, that the others have little or no bearing on the question, and that there still remain reasonable grounds for regarding tuberculous cows' milk as distinctly dangerous to human beings."

Even so, soon after Koch's startling announcement M'Fadyean did not mince matters and had no hesitation in stating that our laws were a scandal as there was no power to inspect cows all over the country. Despite the fact that certain cities had brought in special Acts of Parliament to enable them to examine cattle in their own areas, cows found with tuberculosis of the udder or other acute symptoms of the disease could not be slaughtered against the will of their owners. Such animals could be turned out of the city boundaries, only too often to be milked outside and their milk brought back to the city from country farms.

Notwithstanding the progress which has been made during the last few years the power to examine cattle is still only permissive and not compulsory. Even to-day we see that in one of our most important and largest industrial counties with its highly urbanised districts, there is no general routine examination of milking cattle and as in the county in question there is no county veterinary department such as now exists in most others, it makes one feel that M'Fadyean's remarks about our laws are still only too true. It is owing to these anomalies of interpreting the legislation that the proposal to form a State Veterinary Service has been brought about. We can only hope that under the new system such omissions to carry out the expressed desire of Parliament will cease to exist.

Intimately mixed up with the Milk and Dairies legislation is the question of dealing with tuberculous cattle and thus the introduction in 1913 of the first Tuberculosis Order was a step in the right direction. There can be no doubt that this Order was brought in largely as the result of the teaching of M'Fadyean and others and it was welcomed by M'Fadyean in his Introductory Address delivered at the opening of the Royal Veterinary College in 1913. Although as the result of the War this Order was soon to be revoked, before it had had time to effect any real good, it must have been a real source of satisfaction to Sir John when the present Tuberculosis Order, somewhat modified and strengthened in its scope, was brought in in 1925 to be followed the next year by the Milk and Dairies Order.

We are now in a position to visualise the new Government Veterinary Service taking up intensive measures against contagious abortion and probably also Johne's disease as well as against tuberculosis. The need to legislate against these diseases, which continue to cause so much loss to the cattle owners of the country, was stressed by Sir John in the Inaugural Address given in 1913 already referred to. Although 24 years have gone by without this advice being acted on, we do feel that we stand on the threshold of a new era in the history of veterinary public health.

At present in the United Kingdom there are approximately 224 whole-time veterinarians in the service of local authorities, all of whom are employed in veterinary public health assisted by a large staff of part-time practitioners. The great majority of the former are shortly to be taken over by the Ministry of Agriculture and amalgamated with the present staff of the Ministry who number nearly a hundred. Thus, by April, 1938, along with certain newly appointed recruits, there will be at least 320 whole-time veterinary officers assisted by several hundreds of practitioners available for the new campaign against animal disease.

In a short *résumé* such as this, space does not allow of a more detailed consideration of the researches and publications of Sir John which have a bearing on veterinary public health, although it is hoped that sufficient has been said to indicate the very important part he has played in the progress already made. In conclusion we can only express the hope not only that Sir John M'Fadyean will live to see this formidable army representing the main body of the veterinary profession in Great Britain, of which he is so distinguished a member, take its place in such measures against preventive disease, but that their united efforts may be a credit both to the country and to our livestock which is rightly looked upon as the best in the world.

References.

[1]*Journal of Comparative Pathology and Therapeutics*, **3**, 1890, 352.
[2]*Ibid.*, **4**, 1891, 29-35.
[3]*Ibid.*, **4**, 1891, 158.
[4]*Ibid.*, **4**, 1891, 287.
[5]*Ibid.*, **6**, 1893, 120-144.
[6]*Ibid.*, **6**, 1893, 314-320.
[7]*Ibid.*, **6**, 1893, 353-355.

A SHORT SURVEY OF SIR JOHN M'FADYEAN'S CONTRIBUTIONS TO THE STUDY OF TUBERCULOSIS.

By R. E. Glover.

National Institute for Medical Research Farm Laboratories, Mill Hill.

A.—Equine Tuberculosis.

The existence of tuberculosis in the horse was brought to light by the investigations of Koch (1884) and Nocard (1888), but M'Fadyean was apparently the first observer to record the condition in this country. In the first volume of the *Journal of Comparative Pathology and Therapeutics* (1888), there is a very complete description of three cases of the disease, and M'Fadyean subsequently evinced a great interest in the reaction of the horse to the tubercle bacillus. It is also evident that he was the first worker to indicate unequivocally that the tumourous masses growing in the spleen and elsewhere which until then had been regarded as neoplastic in nature were, in fact, a manifestation of tuberculosis. His description of the three first cases which he examined furnishes an exact account of the nature of the lesions, and there is little that has been added to the anatomo-pathological aspect of the disease during the past 50 years :—

" The spleen contained several tumours, the largest being about the size of a turkey's egg. The tumours were greyish white in colour, and the larger masses were softened and caseous centrally, and partly calcified. One or two smaller growths, apparently greatly enlarged lymphatic glands, were present in the neighbourhood of the hilus. The pieces of lung presented a very unusual appearance, the pulmonary tissue being densely and uniformly infiltrated with a new growth of a minute miliary character. The density of the lung tissue was much increased ; it cut more firmly than normal, but consolidation did not appear to be complete in any part. . . . *Lymphatic Glands.* The bronchial, mesenteric, and hepatic lymphatic glands were greatly enlarged. The largest formed tumours about twice as big as the fist of a man. They had a tolerably firm consistence (firmer than a healthy gland), and on section the largest were found to be extensively caseated towards the centre, and partly calcified. The condition of the glands was thus similar to that of the same parts in the cases previously described in this journal. It may here be remarked that so great was the alteration of some of the glands in size and appearance, that they might readily have been mistaken for true neoplasms, but their position indicated clearly that they were hyperplastic enlargements of the lymphatic glands."

M'Fadyean, of course, did not conclude that all these masses were tuberculous.

" I do not intend to imply by this that every case in which there is lymphatic hyperplasia in the horse, together with the formation of splenic tumours is to be at once set down as tubercular. . . . I have more than once had occasion to examine splenic neoplasms in which I could not demonstrate the tubercle bacillus. . . ."

M'Fadyean explained in several of his earlier communications that there was a widespread belief at this time that the equine species possessed a complete immunity to natural infection. In view of the very distinctive differences in the macroscopic appearances of the lesions in many cases of equine tuberculosis, as compared with the changes which arise in other animals, the conviction which had arisen was not altogether surprising, especially when it is recalled that only six years had elapsed since Koch had discovered the specific bacillus and had provided the link between it and the tissue changes which were then termed *tuberculosis*. Several years were to elapse, however, before the solid and tumourous enlargements of the spleen and lymphatic glands were generally recognized as tuberculous in nature, and the determination of a certain section of the veterinary profession to

ignore the evidence provided by the pathologist is dwelt upon by M'Fadyean in succeeding articles. His careful investigation of a series of equine cases effectively silenced the critics. In 1892, Walley says :—

" By the labours of Koch and others on the Continent, and of my late colleague Professor M'Fadyean in this country, the haze of doubt which surrounded the question has been cleared away ; lymphadenoma is practically consigned to the limbo of doubtfully existing diseases, and equine tuberculosis is recognised as one of the most important and most frequently recurring maladies."

This statement of Walley is undoubtedly too sweeping, but it is an indication of the complete change in outlook which had taken place in the course of a few years.

In 1890, an experiment, undertaken in order to determine whether the comparative infrequency of equine tuberculosis was due to a natural insusceptibility to infection, clearly demonstrated the pathogenicity of the lesions in a natural case of the disease. An aged horse injected intravenously with a suspension of natural material very rich in acid-fast bacilli was found dead on the 21st day after inoculation. At the *post-mortem* examination an extensive miliary tuberculosis of the lungs was discovered, the lesions produced being almost identical with those that are commonly observed in spontaneous cases of the disease. This experiment is of importance, since the susceptibility of the equine species to inoculation tuberculosis was still in doubt. At a Congress in Paris in 1889, Nocard stated that the equidæ were resistant to invasion by artificial means and that the intravenous inoculation of infective material always yielded negative results. In 1896, M'Fadyean had occasion to remark that the horse possessed no immunity against tuberculosis and that instances of the disease were far from rare.

Continuing his investigation, several articles appeared in 1892 embracing twelve fresh cases of the disease. In this series, the occurrence of a characteristic ostitis and periostitis affecting mainly the cervical vertebræ is recorded.

The probable type of the infecting organism in the horse did not escape the attention of M'Fadyean. In 1896, he says that :—

" . . . it may, I think, justifiably be held that there is still strong reason to suspect cow's milk as the most common vehicle of infection in tuberculosis of the horse, and that the practice of prescribing raw cow's milk for sick horses, or of giving it as a fattening article of diet to stallions, is attended with a considerable degree of risk, unless the cows that furnish the milk are known to be free from tuberculosis."

In this article he criticises the suggestion advanced by Nocard that the abdominal type of the disease might be caused by the type of bacillus responsible for tuberculosis in the fowl. Nocard based his assumption on the observation that the guinea-pig, which possesses a high degree of resistance against avian tuberculosis, was also resistant to the equine type. M'Fadyean who, himself, isolated an avian bacillus from a horse at a later date, rightly points out that the proof of this contention was far from complete, and brings forward evidence of his own that organisms of the mammalian type as judged by the production of generalized tuberculosis in the guinea-pig, were recoverable from abdominal cases of the disease.

It is most remarkable that the majority of his observations on tuberculosis in the horse were completed by the year 1896, *i.e.*, at a period when the diagnosis of the disease was ascertained mainly by microscopic methods and occasionally by animal inoculation. Cultural methods were as yet in their infancy, and the recognition of the three main types of the tubercle bacillus, *i.e.*, human, bovine and avian, had to await the fundamental

researches of Koch, Theobald Smith, Griffith and other workers. Subsequent investigations which clearly proved that the bovine type of the organism was by far the most common but that many such strains were of substandard virulence for experimental animals, give the key to the inability of the earlier workers to recognise the exact type of bacillus responsible for equine cases. This is admitted by M'Fadyean in a recent article (1924) in which he recalls early experiments which he undertook in 1900.* Two tuberculin negative yearling cattle which were inoculated subcutaneously with an emulsion from the tuberculous mesenteric glands of a horse, were killed two months later. In each case the reaction to the inoculum was strictly localised to the seat of injection and to the adjacent lymphatic glands. No evidence of generalisation was found. Commenting on these results, M'Fadyean points out that although little notice was paid to this fact at the time of the experiment it now seems admissible to conclude, as a result of subsequent investigations, that the equine bacilli had less than the full virulence of the bovine type for cattle.

The examination of equine cases was now taken up by the Royal Commission on Tuberculosis. In their final report issued in 1911, they noted that certain strains possessed aberrant characters. Five were obtained, all of which on cultural grounds belonged to the dysgonic bovine type; three were of high virulence, but one produced only retrogressive lesions in a series of calves while the other induced slight non-progressive lesions in five out of six calves. These two strains were below the standard virulence of the bovine type for guinea-pigs and rabbits.

In 1918, a remarkable case of infection in the horse with the avian type was described. Apart from a doubtful case recorded by Nocard (1894) to which reference has been made, this is the first authentic example of avian infection in this species. At the *post-mortem* examination the main changes were confined to the small and large intestines, which were abnormally thickened. The macroscopic appearance of the lesions was highly suggestive of Johne's disease—in fact, the case was provisionally diagnosed as falling within this category—and enormous numbers of acid-fast bacilli were observed in smears from the large intestine. An examination of the cultures which were obtained and the results of the inoculation of small animals clearly established, however, that the organism responsible was of the avian type. The article is remarkable for the very complete account of the tuberculous changes seen in the lungs of a mare inoculated intravenously with a culture.

The author points out that owing to the inconspicuous nature of the lesions it is highly conceivable that avian infections in the horse might be overlooked or regarded as of an entirely different nature, and that possible cases of this type are more frequent than the published evidence would suggest.

A somewhat parallel position has arisen in regard to the existence of avian tuberculosis in cattle. Prior to 1918, the disease in this species was regarded as extremely rare, but recent investigations have indicated that its prevalence is greater than has been suspected in the past. It would appear that the lesions in the bovine animal are usually strictly localised to a few glands, are extremely discrete and may be of a transient nature. They may be readily overlooked if the *post-mortem* examination is not conducted with meticulous care, and the presence of such infection in a herd may be revealed only as a result of some aberrant or unexpected results of a tuberculin test.

* *J. Roy. Agric. Soc., Eng.* (1900). **11**, 708.

In 1924, M'Fadyean summarised the results of his 35 years' experience of equine tuberculosis. It is most illuminating that his description of the macroscopic and microscopic features of the disease are practically identical with those which he noted in his initial series of articles. He again points out that the digestive tract is the most common portal of entry, and that lesions which are almost invariably found in the abdominal cavity are obviously of an earlier date than those which may be discovered in the thorax. Cases in which the situation of the lesions would suggest primary lung infection are regarded as extraordinarily rare, if they occur at all, and usually the lung tissues remain completely exempt from lesions for a long time before the animal has begun to lose condition. Attention is also drawn to the extremes of rarity and abundance of the bacilli in the lesions from different cases of tuberculosis in the horse.*

Of the eleven cases examined by M'Fadyean and reported in detail in this article, the cultures from five were subjected to tests in small animals for virulence. Although the results were a little erratic (guinea-pigs, rabbits and goats were used) they do not justify the conclusion that the virulence of any of the strains had been modified by passage through the horse.

Griffith (1937) supports the argument of M'Fadyean in regard to the method of infection in the horse. Discussing his own cases, he says that the routes by which the tubercle bacilli enter the body of horses were clearly in favour of the alimentary canal in eight cases, in four the evidence was inconclusive but pointed strongly to the alimentary tract, while in two infection may have been by the respiratory tract but the evidence was not conclusive on this point. Summarising the evidence to date, Griffith points out that of 55 cases examined in England, bovine bacilli have been isolated in all but two instances, one of which yielded a human and one an avian strain. The bovine strains resembled the more dysgonic types and rather more than a half were fully virulent for test animals. The rest were less virulent, the attenuation varying from very slight to considerable.

B.—The Relation between Human and Bovine Tuberculosis.

Up to 1901, the views on the causes of tuberculosis which were held by Koch were not in serious dispute and the eminent bacteriologists of the day were inclined to follow his lead without question. In this year, however, Koch expounded a theory which was the cause of widespread consternation, and the attitude which he adopted initiated an era of intense controversy. At the meeting of the British Congress on Tuberculosis, held in London in 1901, Koch read a paper entitled : " The Combating of Tuberculosis in the Light of the Experience which has been Gained in the successful Combating of other Diseases," in which he openly stated that bovine tuberculosis cannot be transmitted to man. This pronouncement must rank as one of the most memorable contributions which have been presented on this subject. At a distance of over 35 years it is perhaps difficult for the present generation to realise the importance of this communication or to appreciate the full value of the fundamental researches which followed its publication. The fallacies in Koch's arguments are now accepted as a matter of course, but it must not be forgotten that in 1901 the knowledge of the disease from the bacteriological aspect was in its infancy. The scientific outlook on tuberculosis may have hung in the balance at this moment, and the train of

* Griffith (1937) adds " and even in different parts of the same lesion."

subsequent investigations might have been directed along entirely different lines had these views been accepted without question. To many, the pronouncements of Koch were regarded as almost sacrosanct and it must have required considerable courage to have openly controverted his theories.

Up to the time of the Congress, it was generally believed that the human and bovine forms of tuberculosis were identical. Experiments had been undertaken on the transmission of infective tissues from various sources to calves, pigs, goats, etc., in an attempt to set up infection, and it had been demonstrated that whereas the ingestion of material of human origin was almost without effect on these species, the feeding of tuberculous milk or of portions of tuberculous lungs to cattle invariably set up well marked lesions of the disease. Koch concluded, quite rightly, from these experiments that there was a difference between the human and bovine types,* but he went much further by asserting that there was little danger of the transmission of bovine tuberculosis to man.

The following quotation from Koch's original paper clearly indicates the strong stand which he adopted :—

" But, now, how is it with the susceptibility of man to bovine tuberculosis ? This question is far more important to us than that of the susceptibility of cattle to human tuberculosis, highly important as that is too. It is impossible to give this question a direct answer, because, of course, the experimental investigation of it with human beings is out of the question. Indirectly, however, we can try to approach it. It is well known that the milk and butter consumed in great cities very often contain large quantities of the bacilli of bovine tuberculosis in a living condition, as the numerous infection-experiments with such dairy products on animals have proved. Most of the inhabitants of such cities daily consume such living and perfectly virulent bacilli of bovine tuberculosis, and unintentionally carry out the experiment which we are not at liberty to make. If the bacilli of bovine tuberculosis were able to infect human beings, many cases of tuberculosis caused by the consumption of alimenta containing tubercle bacilli could not but occur among the inhabitants of great cities, especially the children. And most medical men believe that this is actually the case.'›

Koch asserted that the evidence obtained from certain hospitals in Germany showed that primary intestinal tuberculosis in human beings, as judged by *post-mortem* examinations, was very rare. He contended that since there were ample opportunities for the transference of bovine bacilli through the consumption of infected milk it should be of much more frequent occurrence. His statement on this question was most dogmatic :—

" Though the important question whether man is susceptible to bovine tuberculosis at all is not yet absolutely decided, and will not admit of absolute decision to-day or to-morrow, one is nevertheless already at liberty to say that, if such a susceptibility really exists, the infection of human beings is but a very rare occurrence. I should estimate the extent of infection by the milk and flesh of tubercular cattle, and the butter made of their milk, as hardly greater than that of hereditary transmission, and I therefore do not deem it advisable to take any measures against it."

The medical journals of the time vividly portray the tension which was manifested as a result of this contribution.

" The views expressed by Professor Koch in regard to the passing of tuberculosis from man to animals evidently attracted extraordinary attention and Lord Lister's speech as Chairman was followed by the huge assembly with extreme interest, each point made by him being made the occasion for a burst of applause. The matter at issue, he said, was of great importance. If Professor Koch was right then preventive measures would be much simplified, but before the Congress could give its consent to the hypothesis the most complete investigations must be undertaken."†

---

* In 1898 Theobald Smith as the result of his own observations, suggested the existence of distinct types of the mammalian tubercle bacillus, *i.e.*, human and bovine, but the significance of his findings was not fully appreciated.

† (1901) *Lancet*. 79, ii, 231.

Cobbett, commenting on this Congress, says :—

" The announcement of the distinction between bovine and human tuberculosis, and the assertion that the latter is not transmissible to man, provoked at the time a storm of opposition, especially among those who were striving, in the interest of human public health, to eradicate tuberculosis from among cattle. Nocard, Bang, Woodhead, M'Fadyean, Crookshank and Delépine all more or less strongly opposed Koch at the Congress. Nocard admitted that there was a tendency to exaggerate the danger of bovine tuberculosis to man, and he was glad that Koch had checked this movement. But he feared lest the reaction might go too far. ' Bovine tuberculosis,' he said, ' plays a very secondary part in human tuberculosis, but as long as this danger exists at all it cannot be suppressed by denying it '."

The important part which was played by M'Fadyean in this controversy cannot be overestimated. Up to this time he had been in agreement with Nocard in suggesting that while bovine tuberculosis was communicable to man, it was necessary to avoid the danger of overstressing its importance. In 1899, when opening a discussion on bovine tuberculosis at the annual meeting of the National Veterinary Association, he said :—

" I think I am justified in saying that in the past exaggeration has been freely indulged in by many of those who have sought to trace a connection between the human and the bovine disease. . . . But although I think that too much importance is still attached to tuberculous milk as a cause of human tuberculosis, I maintain that there is evidence to show that there is a distinct menace to human health existing at the present time through the prevalence of tuberculosis among cattle."

It is not surprising, therefore, that at the Fourth General Meeting, there was a full attendance to hear Professor M'Fadyean's address. Much interest was taken in the delivery of this paper as it was an open secret that it would be a direct answer to the views of Professor Koch.

At this meeting he at once adopted a firm attitude in which he found himself diametrically opposed to Koch. In trenchant sentences based on his own knowledge of bovine tuberculosis he controverted the arguments put forward by Koch with great precision. The following extracts taken from his communication to this Congress merit reproduction :—

" As recently as a few days ago, when I was mentally arranging the material for the paper which I have now the great honour of submitting to this Congress, I was under the impression that it would not be necessary to formally prove that the term tuberculosis as it is now employed by medical men and veterinary surgeons relates to one and the same disease. I thought that I might ask my audience to accept it as proved, and generally admitted, that tuberculosis in man is caused by a single definite species of organism—the tubercle bacillus ; that this organism is also the cause of the disease to which veterinary surgeons apply the term tuberculosis in the case of cattle and other domesticated species, and that there therefore existed a *prima facie* case against the germs formed in the bodies of tuberculous animals as a possible source of tuberculous disease in human beings.

To-day, however, the position of anyone who undertakes to discuss the intercommunicability of human and bovine tuberculosis is very different from what it would have been a week ago, for in the interval the greatest living authority on tuberculosis—the world renowned discoverer of the tubercle bacillus, and the man to whom we are mainly indebted for our knowledge of the cause of tuberculosis—has declared his conviction that human and bovine tuberculosis are practically two distinct diseases. I do not know how far the reasons assigned by Dr. Koch for the opinion which he now holds on this question may have commended themselves to the members of this Congress, and I am overwhelmed at finding myself in a position which compels me to offer some criticism on the pronouncement of one the latchet of whose shoe I am not worthy to unloose."

M'Fadyean maintained that there still remained reasonable grounds for regarding tuberculous cow's milk as distinctly dangerous to human beings. He says :—

" Opinions varied as to the frequency with which this transmission of tuberculosis from one species to the other occurred, but practically never within the last eighteen

years regarding the possibility and probability of such reciprocal infection. What are the grounds upon which we are asked to discard convictions that appeared to rest on such a solid basis ? I shall endeavour to state them briefly, as I understand Dr. Koch's train of reasoning.

(1) The bacilli found in cases of bovine tuberculosis are much more virulent for cattle and other domestic quadrupeds than the bacilli found in cases of human tuberculosis.

(2) This difference is so marked and so constant that it may be relied upon as a means of distinguishing the bacilli of bovine tuberculosis from those of the human disease, even assuming that the former may occasionally be found as a cause of disease in man.

(3) If bovine bacilli are capable of causing disease in man, there are abundant opportunities for the transference of the bacilli from the one species to the other, and cases of primary intestinal tuberculosis from the consumption of tuberculous milk ought to be of common occurrence. But *post-mortem* examination of human beings proves that cases of primary intestinal tuberculosis are extremely rare in man, and therefore it must be concluded that the human subject is immune against infection with the bovine bacilli, or is so slightly susceptible that it is not necessary to take steps to counteract the risk of infection in this way. . . .

It cannot be admitted that the low virulence of human bacilli for cattle proves, or even makes it probable, that bovine bacilli have only a feeble pathogenic power for man. That might have been held to be probable if it had been shown that bovine bacilli were very virulent only for cattle but since it is well established that these bacilli are highly dangerous for such diverse species as the rabbit, horse, dog, pig and sheep, and, in short, for almost every quadruped on which they have been tried, it appears to be highly probable that they are also dangerous to man. At any rate it is impossible to cite any ascertained fact relating to other bacterial diseases that makes the contrary conclusion probable. It is well known that the majority of disease-exciting bacteria are harmful to only one or two species, but all those that are common to all the domesticated animals are also pathogenic to man."

He reinforced his arguments by a reference to the statistics on the incidence of primary intestinal tuberculosis which were by no means as numerous as Koch would have them believe. He collected figures obtained by Dr. Still in England and by Dr. Shennan in Scotland, showing that in approximately 28 per cent. of the cases of tuberculosis in children infection appeared to have taken place primarily through the intestinal tract. He says :—

" Precisely the contrary conclusion is the one that must in the meanwhile be drawn with regard to the state of affairs in this country, *viz.*, that, at least in children, primary infection by way of the alimentary canal is comparatively common."

M'Fadyean then presents striking figures on the incidence of udder tuberculosis in cattle :—

" Since about one cow in 50 is the subject of tuberculosis of the udder, and the average number of cows in the milking herds of this country is less than 50, it follows that the majority of dairies and farms supply milk that is free from tubercle bacilli, or at least does not contain any derived from this source. On the other hand, when the infective material is present it operates with the greatest intensity in the milk of single cows, and in the mixed milk from small herds."

He goes on to point out the possible value of the tuberculin test—still in its infancy and as yet unproved—and foreshadows with great accuracy the provisions of the Tuberculosis Order, which was not introduced until 12 years had elapsed :—

" The present state of the law, or rather the almost entire absence of any law, dealing with tuberculous udder disease in cows is a scandal and a reproach to civilisation. It scarcely sounds credible, but it is a fact that the owner of a cow in the most advanced state of tuberculosis, and exhibiting the most manifest signs of udder disease, may sell that cow's milk for human food as long as the sale has not been specially interdicted on the certificate of a veterinary surgeon, and no penalty attaches to this crime of deliberately or carelessly placing on the market a food material charged with the germs of a dangerous disease."

His conclusions were much in advance of current opinion and are a striking example of his prevision of steps which were eventually taken but only after much delay :—

" In conclusion, I would venture to express the earnest hope that the Congress will not endorse the view that it is inadvisable to take any measures to prevent the transmission of tuberculosis from the lower animals to human beings. To justify the introduction of measures to that end it is not necessary to contend that this is a common measure of infection, or that the danger arising from milk can for a moment be compared with that present in human sputum. The inhalation of tubercle bacilli expelled from the bodies of human patients is doubtless the great cause of human tuberculosis, and every practicable means of preventing infection in that way ought to be employed : but, at the same time we ought not to concede to the milkman the right to sell us tubercle bacilli, even if we were assured that—like Dr. Koch's experimental pigs—we had nothing to fear beyond the development of ' little nodules here and there in the lymphatic glands ' of our necks and ' a few grey tubercles ' in our lungs."

It was mainly on account of the stand which was made by M'Fadyean and others that the Royal Commission on Tuberculosis was established. It was composed of a number of eminent scientists and it is of interest that M'Fadyean is the sole survivor of this distinguished company. The deliberations of the Royal Commission were continued until 1911, when the final report was issued. Their researches, which amply justified the attitude which was adopted by M'Fadyean, successfully disposed of the theory of the insusceptibility of man to bovine tuberculosis. By 1908, however, the storm of opposition to Koch's views had reached such a height that at the International Congress at Washington at which Koch again reiterated his views regarding the low invasiveness of bovine tubercle bacilli for the human subject, the great man found that he was so strongly opposed and that the evidence to controvert his dogma was so potent that he gave way and admitted that his views might require modification.

C.—Natural Transmission of Tuberculosis.

Reference may here be made to another controversy in which M'Fadyean played a leading part. In 1903, von Behring advanced the theory that pulmonary tuberculosis was of intestinal origin. He maintained that the tubercle bacillus was capable of passing through the wall of the gut and of localising in the pulmonary tissues without leaving any trace of its path through the abdominal cavity. This theory was entirely contrary to current opinion, *viz.*, that tuberculosis of the lungs was essentially an infection of inhalation, and von Behring's suggestion was widely criticised by most eminent authorities on tuberculosis, and was not seriously entertained as a working hypothesis for many years. Later, however, support was obtained from Vallée and other French workers, and in particular from Calmette and Guérin, who undertook an extensive series of experiments on this question. These workers claimed that they could induce severe pulmonary tuberculosis in the goat by feeding large doses of bovine tubercle bacilli through an oesophageal tube. In one case in particular, the thoracic lesions were widespread and severe, whereas the lesions in the mesenteric glands were of microscopic dimensions. The interpretation which Calmette put upon this and other experiments was that the respiratory tract offered a potent barrier to the entry of bacteria and that the most likely route of infection was by the digestive tract, the organisms reaching the lungs not by inhalation but by passage through the thoracic duct.

M'Fadyean strongly contested the conclusions which were drawn from this experiment. In 1910, he published an extremely interesting and

illuminating paper entitled, "What is the Common Method of Infection in Tuberculosis?" He summarises the two schools of thought in the following paragraphs :—

"The case in favour of the view that inhalation, and not ingestion, is the common natural method of infection in human and bovine tuberculosis may be briefly stated as follows :—

(1) In both these species the commonest seats of the primary lesions are the lungs and the bronchial glands, and it is a reasonable deduction from this localisation of the primary lesions within the thorax that the bacilli which determined these lesions gained the pulmonary tissue with the inspired air. *A priori*, this explanation of the origin of primary intrathoracic lesions is to be preferred to any other because it is the simplest.

(2) The view that the air passages constitute the channel of infection in cases of primary intrathoracic tuberculosis is confirmed by the results of experiments, which show : (*a*) that when susceptible animals are caused to inhale tubercle bacilli the primary lesions develop within the thorax, and (*b*) that primary intrathoracic lesions cannot readily be set up by causing animals to swallow tubercle bacilli, or by infection through any other channel than the air passages.

Similarly, the position of those who regard ingestion as the common natural method of infection in human and bovine tuberculosis may be briefly formulated thus :—

(1) It is affirmed that experimental infection is more certain when the bacilli are swallowed than when they are inhaled, and that in cases of experimental tuberculosis set up by feeding the primary lesions are frequently or generally intrathoracic.

(2) The occurrence of primary intrathoracic lesions in natural or experimental cases of tuberculosis resulting from the ingestion of bacilli is explained by supposing that the bacilli which reach the intestine may, after absorption into the lymphatic vessels, be carried rapidly through the bowel wall and mesenteric glands, and thus gain the lung tissue by way of the thoracic duct.

(3) It is declared to be difficult or impossible to determine tuberculosis with lesions primarily intrathoracic by causing animals to inhale tubercle bacilli."

He then critically examines in great detail the experimental evidence which had been tabulated by Calmette.

"The authors obviously attached great importance to the fact that there were pulmonary lesions in this kid,* as the statement is printed in italics. It need hardly be pointed out that in reality this experiment is not of the least value in enabling one to determine whether cases of primary pulmonary tuberculosis are the result of infection by inhalation or not, because in this experimental animal the disease was not confined to the lungs. The experiment therefore not only does not prove that primary pulmonary tuberculosis cannot be produced by inhalation, but it also fails to prove that primary pulmonary tuberculosis can be produced by ingestion. . . . Reviewing the whole of these experiments by Calmette and Guérin, one cannot fail to be struck with their absolute insufficiency to prove or even to make probable the point which the authors are seeking to establish. In reality the experiments were too few in number to justify any very sweeping conclusion, but so far as they go they indicate that the usual result of infection by ingestion is the development of a tuberculosis which primarily involves the mesenteric glands. It is true that some of them showed that when animals are infected by causing them to swallow doses of bacilli that must be considered enormous as compared with those that are commonly in operation in natural circumstances the disease may become rapidly generalised, with the result that tubercle bacilli or even definite tuberculous lesions may be found in the lungs or thoracic glands within a few weeks after the act of infection. But that falls far short of proof that a tuberculosis with well-defined macroscopic lesions confined to the thorax can be set up by introducing tubercle bacilli into the alimentary canal."

M'Fadyean then proceeds to analyse some experimental data obtained by the Royal Commission on Tuberculosis which appeared to afford positive evidence that Calmette's theory was founded on a false assumption. In

* A kid, born of a goat infected artificially with bovine tubercle bacilli at an advanced stage of pregnancy, died 51 days after birth. The *post-mortem* examination showed an intense tuberculous lymphadenitis of the mesenteric glands but the lungs were also crammed with very young translucent miliary tubercles.

these experiments a comparatively large number of calves was infected with virulent bovine bacilli. The results indicated that at any rate in the case of cattle, as a result of an infective dose given by the mouth, more or less conspicuous lesions were almost invariably to be found in the mesenteric and other glands associated with the digestive tract. The striking fact which emerged from these experiments was the extreme difficulty which was experienced by the workers for the Royal Commission in setting up a rapid progressive tuberculosis in young calves which have generally been regarded as highly susceptible to the disease. In addition to the findings of the Royal Commission, M'Fadyean draws attention to a number of investigations which have shed further light on the relative importance of infection by inhalation and by ingestion respectively. It is pointed out that in experiments run in parallel with measured doses of tubercle bacilli administered by these two routes, it is strikingly shown that there is a much greater certainty of infection by inhalation as compared with ingestion; moreover, the smallest dose which was required to induce infection by mouth with certainty might be over 100 times as great as that which set up lesions when given in the form of a spray.

As always, his conclusions are extremely cautious. He says:—

"The whole of the experimental evidence on which the theory of the intestinal origin of pulmonary tuberculosis in man was built up has been swept away, and valuable new support has been provided for the older inhalation theory: but one ought to avoid the mistake of denying any importance to infection by ingestion either in man or in cattle, or of asserting that tubercle bacilli which enter the body by way of the alimentary canal are never the cause of tuberculosis with lesions apparently primary on the lungs."

So far as can be gathered, M'Fadyean himself never undertook any experiments on the relative importance of inhalation and of ingestion, but his views based on a critical survey of the investigations of the period were very definite.

D.—Control of Bovine Tuberculosis.

In many of his articles M'Fadyean emphasised the widespread incidence of tuberculosis in dairy cattle, and he returned to this theme again and again. He also held very definite views on the feasibility of eradicating the disease by systematic tuberculin testing and the elimination of reactors, and considered that, in so far as this country was concerned, the economic factor would probably prove an insuperable barrier to the introduction of such measures. In 1896 he says:—

"To some it may seem an obvious point that if it is a contagious disease it ought to be brought under the operation of the Diseases of Animals Act. But before we subscribe to that conclusion there are one or two things to be taken into consideration. To ask for the scheduling of tuberculosis as a contagious disease is a sort of meaningless request, unless we have made up our minds as to the purposes for which it is to be so scheduled. Is it to be scheduled for simple notification, or are we going to ask to have applied to it the measures enforced against cattle plague, foot-and-mouth disease, glanders, or pleuro-pneumonia? The measures directed against these had for their object the complete eradication of the disease, and to that end notification, slaughter, and isolation were compulsory." . . . . . "In the case of cattle plague and pleuro-pneumonia, the disease was got rid of by the remorseless slaughter of every diseased animal and of every animal known to have been exposed to the infection. Nothing else would have sufficed in the case of these diseases, because when an outbreak occurred there was no means of picking out the healthy from those which had already caught the infection. A few years ago the same could have been said of tuberculosis, and as long as that was the case the stamping out of the disease seemed impossible on the score of cost. But the discovery of the marvellous diagnostic property of tuberculin

gave the question quite a new aspect, for it put in our hands a means by which we could with great certainty separate the healthy from the already infected in any given outbreak.

"Several methods of taking advantage of this discovery have been proposed. The most radical one was that planned and for a short period put into operation in the State of Massachusetts two years ago. Under an order issued by the State Board of Cattle Commissioners, every bovine animal in the State was to be tested with tuberculin, every animal that reacted was to be slaughtered, and a strict quarantine, combined with the tuberculin test, was to be imposed on all imported cattle. Apparently even in that small State, in which tuberculosis is nothing like so prevalent as it is here, the plan proved unworkable, and it was soon abandoned. In the case of Great Britain such a method of attacking the disease is altogether out of the question, as several millions of money would be required to meet the claims for compensation."

Again in 1899 in an Editorial dealing with the stamping out of tuberculosis, he remarks : —

"The difficulty of diagnosis, which before the discovery of tuberculin stood as an insuperable barrier to stamping-out measures, has now almost entirely disappeared, but a new and equally great obstacle has been brought to light in the discovery that about one-third of the adult animals of the bovine species in Great Britain are already affected with tuberculosis. In support of this estimate it may be mentioned that during the past two years particulars relating to the testing of 4,379 cattle have been communicated to the Editor by members of the Veterinary profession practising in various parts of England and Scotland, and that out of that number 1,389, or 31.7 per cent., reacted. As with few exceptions the animals tested were apparently healthy, there does not appear to be any ground for believing that if the whole of the breeding cattle in the country were tested the proportion of them found to be affected would be much less.

"The discovery that about one-third of the breeding stock of the country are already affected with tuberculosis has made it impossible for any sane person to maintain that the Board of Agriculture ought to schedule tuberculosis under the Diseases of Animals' Act, and proceed to apply to it the measures which were successful in stamping out cattle plague and foot-and-mouth disease. . . ."

His views on this aspect of the question remained unaltered, and he sums up his attitude in 1930 at the 11th International Veterinary Congress by stating : —

"Dr. Watson appeared to prefer to attack tuberculosis by the method adopted in the U.S.A.,* but the conditions in Europe were quite different, for whereas in the United States the proportion of cows affected with the disease did not exceed 3 per cent., or in Canada 6 per cent., in most European countries it could not be put lower than 30 per cent."

It is not surprising, therefore, that the possibility of protecting cattle by means of vaccination engaged his attention at an early date, and was the subject of several series of experiments which he undertook at the Royal Veterinary College by himself or in collaboration with his younger colleagues who were privileged to be associated with him. Already in 1901 and 1902 he had completed a preliminary investigation in which he showed that two tuberculin positive heifers, one of which had received several large doses of tuberculin prior to the test dose, were highly resistant to the intravenous injection of a suspension of bovine tissue rich in acid-fast bacilli. He also gives details of two tuberculin negative animals which were first injected without untoward effect with tissue emulsion from birds affected with tuberculosis and which were subsequently tested intravenously with infective bovine material on repeated occasions. The two animals survived 2½ years and 3½ years respectively. Doubtless these results inspired the more comprehensive series of experiments which were undertaken at a later date. They were spread over a number of years and

*viz., The slaughter of reacting animals.

furnished material for an article appearing in 1913 entitled "Experiments regarding the Vaccination of Cattle against Tuberculosis by the Intravenous Injection of Tubercle Bacilli of the Human and Avian Types."* It is stated in the preamble that :—

"The principal purpose of the experiments which are described in this article was to test the effect of intravenous inoculations of tubercle bacilli of the avian type in immunising cattle against bovine tubercle bacilli. Included in the experiments there are also animals which were inoculated intravenously with tubercle bacilli of the human type, but these were employed mainly in order to enable one to compare the immunity or increased resistance which follows vaccination with the two different types."

The article is mainly concerned with the avian bacillus as an effective immunising agent since it is freely admitted that the high hopes held out by von Behring in his original communication regarding the vaccination of cattle with the human type had not been confirmed. It is true that the immunity set up by the human strain was fairly substantial but it was not of a very lasting character. Moreover, the fact that the organism used for the vaccine might become located in the udder and pass out in the milk,† made it impossible to consider the vaccination of cattle with this type a safe procedure. These objections, in the minds of M'Fadyean and his co-workers, did not arise in so far as the avian bacillus was concerned.

In the earlier experiments which have already been quoted two heifers were injected with avian bacilli from natural tissues and were tested with an organ suspension from tuberculous cattle. In view of the lengthy period of survival after the test dose it seemed legitimate to conclude that there was distinct evidence of an increased resistance, but as the experiments were not controlled and the weight of the infective dose was not known there was a lack of precise information on this point. In the present series of experiments calves were immunised by the intravenous inoculation of weighed doses (varying from 10-50 milligrams) of human or avian bacilli as a single dose or repeated two or three times. In the preliminary trials the immunity was tested by the intravenous inoculation of 3-4 milligrams of virulent bovine bacilli, but as this dose proved to be too severe, amounts of the organism varying from 5-50 milligrams were given subcutaneously in the succeeding experiments.

The results showed the superiority of human over avian strains from the point of view of the enhancement of resistance to artificial infection which, as M'Fadyean rightly points out :—

"might have been expected in view of the much closer relationship between the human and bovine type of bacilli than between the latter and the avian type." The fact does emerge, however, from this experiment that ". . as a rule vaccination with avian bacilli greatly increases the resistance to subsequent infection with bovine bacilli. That conclusion emerges immediately when the results of the test inoculation in the calves thus vaccinated are compared with those which followed in the control animals. And it is of interest to note that there is other evidence than that obtained by comparing the *post-mortem* records to show that the calves vaccinated with avian bacilli, as well as those vaccinated with human, had acquired an immunity much above that which is natural to young animals of the bovine species. Such evidence was nearly always furnished by the appearance of the local lesion which developed at the seat of inoculation with bovine bacilli, and by the behaviour of the temperature after that inoculation."

---

* M'Fadyean, J., Sheather, A. L., Edwards, J. T. and Minett, F. C. (1913.) **26**. 327.

† The secretion of human bacilli in the milk over a long period was demonstrated by A. S. Griffith in the course of his work for the Royal Commission on Tuberculosis.

The conclusions which were drawn from this important series of experiments were : —

"(1) By the intravenous inoculation of avian tubercle bacilli it is possible to confer on healthy calves a markedly increased power of resistance to infection with bacilli of the bovine type."

"(2) Such a method of vaccinating young cattle against tuberculosis involves little or no risk to the animals."

"(3) When the vaccination of young animals against tuberculosis is considered advisable avian bacilli should be preferred to human, in order to avoid the danger of infecting human beings with bacilli persisting in the bodies of the vaccinated animals and passed out with their milk."

In 1914 he reviewed the position in regard to bovine tuberculosis in a masterly paper prepared for the 10th International Veterinary Congress which, as is well known, was never discussed owing to the abandonment of the Congress on the outbreak of war. His views on vaccination are of considerable interest : —

"As has already been stated, in principle there is only one method by which tuberculosis can be eradicated from any herd, *viz.*, by trusting to tuberculin for diagnosis, and to isolation in order to preserve the still healthy animals from infection."

"Protective inoculation or vaccination of young healthy stock as a means of dealing with the disease has not fulfilled the earlier expectations. It is possible that in special circumstances it may be desirable to vaccinate calves soon after they are born, but it is scarcely going too far to say that the vaccination is a hindrance rather than a help when the object aimed at is the building-up of a tubercle-free herd. It is a hindrance because its employment is apt to draw attention away from the supreme importance of isolation as the safeguard against infection of healthy animals, and because it seriously interferes with the subsequent use of tuberculin in order to determine whether the vaccinated animals have remained free from infection with bovine bacilli or not."

It is of considerable interest that of recent years the experiments thus planned and executed by M'Fadyean with the avian bacillus have been repeated in an almost identical manner by Buxton and Griffith* with B C G vaccine. The consensus of opinion admits that this strain, which is of mammalian origin, is entirely apathogenic for cattle. The most favourable results from the immunological point of view have been obtained with doses exactly comparable to those utilised by M'Fadyean in his experiments with the avian bacillus, using the same route of injection, viz., intravenous. At the time (1913) that M'Fadyean's observations were published, Calmette had only just commenced his trials with B C G, but it is remarkable how closely M'Fadyean foreshadowed the investigations which were to follow at a much later date ; or to put the matter in another way, how little the train of present day investigation has departed from the methods which he employed.

For many years he adopted a waiting policy in regard to B C G, but he set forth his considered opinion in 1930 when at the 11th International Veterinary Congress in reply to the criticism of Watson, he said : —

". . with regard to the BCG vaccine that of its safety was the more important because if it was not safe the question of its efficiency fell to the ground. In his speech on the previous day Dr. Watson had complained that the case for the employment of the vaccine had been supported by theories, assumptions, claims and propaganda, and expressed the opinion that no one who considered the matter without bias could regard the vaccine as safe. He (the speaker) believed on the balance of evidence that the vaccine was safe in the sense that the bacilli of which it was composed did not multiply in the body of the calf and did not cause an appreciable injury to the animal's general health."

---

* *Lancet.* (1931.) **220**. 393.

E.—The Tuberculin Test.

There can be no doubt that M'Fadyean was primarily responsible for the popularising of the tuberculin test for cattle in this country. In 1891 his first observations on this subject are recorded. Two animals believed to be tuberculous were tested by the subcutaneous method. The first, injected at short intervals, gave clear-cut reactions on three occasions which admitted of no doubt that the introduction of tuberculin had induced a significant rise in temperature, but subsequently it became tuberculin negative. The second cow failed to react: nevertheless very extensive pulmonary lesions were found at autopsy.

It is evident that M'Fadyean immediately grasped the significance and the limitations of the test. He postulated, for example, that in the first cow a certain degree of tolerance was induced by the repeated injections of tuberculin and remarked that: —

"whereas in the first experiment 20 milligrammes had sufficed to send the temperature up to 105·6°, in the last a dose twenty-five times greater did not raise it 1° above what it was immediately prior to the injection."

He also commented on the second animal which failed to react and inferred that the disappointing result might have been due to the advanced state of the lesions. He says: —

"It is therefore permissible to hope that there has been discovered a substance that will enable veterinary surgeons to diagnose tuberculosis in dairy cattle with greater precision that has hitherto been possible, but the result obtained with the second cow above referred to proves that difficulty of diagnosis may still exist, even in cases where the lesions are very extensive. In all the experiments yet published the tuberculous animals appear to have been in a rather advanced stage of the disease, but it still remains to be proved whether any discernible reaction will follow the injection of Koch's fluid when the lesions are of small extent."

It must not be thought, however, that M'Fadyean immediately accepted the tuberculin test as an invaluable means of diagnosing the disease. It was only after he had satisfied himself by a series of personal investigations that, when carefully applied under properly controlled conditions it was sufficiently accurate for general employment, that he gave it his unmeasured approval. In 1891, he undoubtedly experienced some considerable doubt as to the reliability of the biological test, for in an editorial on the diagnostic value of tuberculin in cattle, he says: —

"In our last issue we published a number of experiments with tuberculin on cattle that had at that date been carried out in this country and on the Continent. The results were not uniform, but the majority appeared to show that the agent acted on cattle in pretty much the same way as on human beings, so far at least as regarded its effect on the body temperature. In the present number we summarise a further and larger instalment of experiments of the same sort, but it must be confessed that these are probably not yet sufficient to warrant a final conclusion regarding the diagnostic value of the agent.

"The results obtained and the conclusions drawn in the different experiments are contradictory to a surprising degree, and they are hardly explainable on any other suposition than that Koch's fluid is by no means of uniform composition or strength." . . . . "The most discouraging feature in the results hitherto obtained is that in a considerable proportion of cases, and in the hands of perfectly trustworthy observers, the temperature reaction in non-tuberculous animals has been quite as marked as it sometimes is in tuberculous animals. It is evident that the proportion of cases in which non-tuberculous animals react does not require to be large in order to deprive the agent of its whole diagnostic value; and unless that proportion should turn out to be smaller than it has been in the experiments hitherto made, Koch's fluid will not find a great sale even as an aid to diagnosis."

He persisted, however, with his observations. As opportunities arose groups of animals were tested with tuberculin and immediately subjected

to *post-mortem* examination. In 1893, records of 75 such animals are given in detail. They are divided into two groups, viz., those in which the temperature rose to 103° F. and those in which it remained under 103° F. In the first group comprising 36 beasts, 31 showed tuberculous changes and 5 were free from visible lesions : in the second group 19 were tuberculous and 20 were non-tuberculous.

"It therefore cannot be gainsaid that in 19 out of 51 tuberculous animals tuberculin failed to excite a diagnostic elevation of temperature. So much by way of summing up the points that are unfavourable to tuberculin. But on the other side it ought not to be forgotten that out of the 51 tuberculous animals included in the foregoing experiments probably not more than three or four could by the most searching clinical or bacteriological examination have been certainly recognised as affected with tuberculosis." . . . "In conclusion, I have no hesitation in saying that, taking full account of its imperfections, tuberculin is the most valuable means of diagnosis in tuberculosis that we possess. The discovery of tubercle bacilli is, of course, the only means of arriving at a positively certain diagnosis, but that means, for reasons already set forth, has an exceedingly restricted sphere of application in veterinary practice. Without tuberculin even the sharpest and most experienced practitioner is powerless to detect tuberculosis in its early stages; with it, he will find it possible to detect the majority of cases even when the lesions are very slight. It is probable that by using the tuberculin test twice, with an interval of some days between the injections, the proportion of errors in diagnosis would be very small."

Later in the year, however, corroboration of the accuracy of the test was obtained. A herd of 25 animals was tested : in 24, the temperature rose to 103° or more, and in one remained under 103°. The 24 reactors were found to be tuberculous to some degree, while the non-reactor was free from lesions.

In 1899, the Royal Agricultural Society of England appointed a Committee to investigate the properties of tuberculin. This step was taken since the reliability of the test had been questioned both in the British Isles and on the Continent, and it was thought that an authoritative statement by an influential and impartial Committee would be of value. The experiments which were undertaken to this end were supervised by this body and a report was issued signed by Lords Brougham and Vaux, Sir Nigel Kingscote, Sir George Brown, Lord Arthur Cecil, and Professor M'Fadyean. The plan of the experiments was to secure apparently healthy cattle and test them with tuberculin. If they failed to react they were presumed to be free from the disease and were then experimentally infected with tuberculosis in order to follow the course of the resistance to tuberculin. The survey was completed by *post-mortem* examinations to determine the extent of the lesions and to estimate, if possible, their age.

As a result of this investigation the Committee came to the conclusion that : —

"1. With few exceptions manifest tuberculous disease is discoverable at the *post-mortem* examination of animals in which there is a decided rise of temperature after the injection of tuberculin."

"2. As a rule, no such lesions are to be found in those animals in which there is no decided rise of temperature after the injection of tuberculin; but the exceptions to this rule are more numerous than in the preceding case."

The causes of these errors are discussed in detail and means which might be taken to avoid them are detailed : —

"Even when full account is taken of these possibilities of error, the Committee are of opinion that tuberculin is an agent of great value, far surpassing all other methods of diagnosis, and that if properly employed, it is calculated to render immense service in dealing with tuberculosis."

One of the objects of the investigation was to ascertain the exact period after infection that a reaction to tuberculin could be expected. M'Fadyean comments editorially on this aspect of the question :—

"It was hoped in this way to add to the already existing knowledge regarding the general question of the accuracy of tuberculin as a diagnostic agent, and also to obtain information concerning a point which at that time was very obscure, *viz.*, the period which elapses between infection and the earliest moment at which an injection of tuberculin will provoke a reaction. At present we desire to call attention only to the information with regard to this latter point which the results of the experiments provide. In this respect the results were somewhat remarkable, or at least different from what most people would probably have expected. Briefly stated, the experiments indicated that with different methods of infection, and even when animals are infected in the same way, the period which elapses before a distinct reaction to tuberculin can be obtained is very variable, and may be anything from eight days to over seven weeks. The actual periods observed were from eight to twenty-three days when the animals were infected by intravenous injection, from eight to fifteen days with subcutaneous inoculation, and from eight to fifty-one days when the infective material was administered by the mouth. It ought to be observed that it is possible, though it cannot be said that it is at all probable, that what for the sake of brevity may be called the period of incubation, may have been modified by the preliminary test with tuberculin to which the animals had been subjected in order to ascertain whether they were the subjects of naturally contracted disease or not, and by the repeated injections which were made after infection to discover the earliest moment at which a reaction could be obtained. This possible source of error could only have been avoided by using a very much larger number of animals for experiment, so as to permit of proportionally longer intervals between the tests. As already said, however, it does not appear to be at all probable that the injection of an ordinary dose of tuberculin, even when several times repeated, has any effect in preventing an ulterior reaction when it does not itself provide a reaction. In some cases the animals were tested once a week after infection but in the later experiments the interval between the injections was purposely made longer." . . . . . "It is a fairly safe prediction that the facts brought to light by the experiments to which we have referred will be not unwelcome to those who have all along industriously endeavoured to spread the notion that tuberculin is an agent of no value in the diagnosis of tuberculosis, and we may confidently expect to see the fact that the property of reacting is not acquired by an animal on the day on which tubercle bacilli enters its body put forward as a reason for entirely abandoning the tuberculin test. It need hardly be pointed out that there is neither logic nor reason in such an attitude. When the test is properly carried out its imperfections are almost entirely in the direction of failing to detect the disease, and very rarely in the way of incriminating an animal that is free from tuberculosis. At the present time the agitation against the employment of tuberculin is fostered mainly by those who are in no way anxious for the discovery of an infallible method of detecting tuberculosis in the living animals, and who, having animals for sale, sigh for the return of the days when good condition and the absence of a cough were unhesitatingly accepted by a purchaser as satisfactory proof of freedom from the disease."

The Royal Commission on Tuberculosis, in their report of 1898, quoted M'Fadyean's opinion on:—

"his most implicit faith in tuberculin as a test of tuberculosis when it is used on animals standing in their own premises and undisturbed," and adds, "We entirely accept these conclusions and entertain no doubt as to the value of tuberculin, provided the test is applied by a competent veterinary surgeon and that the tuberculin is of trustworthy quality."

By the end of the war he was convinced that tuberculin had proved its value, and in 1925, speaking of the intradermal test, he said :—

"There is no doubt that the intradermal test may give good results when properly carried out, but it by no means follows that it would be wise to adopt it as either the exclusive or the main method for testing cattle in this country. The subcutaneous test, in spite of the fact that it necessitates the frequent taking of temperatures, is simpler than the intradermal test, as every practical person will

realise when the Committee's diary* on page 99 is read; and there is an immense body of evidence to show that, when used on cows and other cattle accustomed to housing and handling, even without the supervision of experts, it has often yielded better results than the Committee obtained with the intradermal."

"In all three methods of testing the correctness of the diagnosis depends greatly on the judgment of the veterinary surgeon who is entrusted with the duty, and the search after a method that will invariably give clear-cut results is probably a 'Will-o'-the-wisp.' The subcutaneous test, however, has the advantage that it demands less skill and experience than either the intradermal or the ophthalmic test, because in it the temperature effect, which is the criterion of reaction, can be easily ascertained. Furthermore, what has been observed can be reported with a degree of precision which is unattainable in the other two methods."

These remarks leave no doubt in the mind of the reader as to his views on the value of the subcutaneous test†.

In 1914, M'Fadyean collected into one article entitled "Experiments regarding Different Methods of Tuberculin Testing"‡ observations on the value of the subcutaneous, ophthalmic, and intradermal tests respectively. It is difficult to overestimate the importance of this contribution in which are recorded results of an extensive series of experiments on the temperature reactions which follow the subcutaneous inoculation of infected animals with tuberculin, reactions induced by the intracutaneous and conjunctival tests and the comparative merits of the three methods. Many of these experiments were undertaken in animals artificially infected with cultures of human or avian bacilli, but in the compilation of the figures of the comparative value of the three tests calves infected with the bovine tubercle bacillus were mainly employed. It may be noted, however, that the results in cattle sensitised with human and avian strains did not differ to any marked degree from those obtained in the latter group.

In conducting the subcutaneous test the animals were usually tested on several occasions using both homologous and heterologous tuberculins. In general homologous tuberculin was extremely accurate, especially as an initial test, while the results of the second and third tests, although not so good, were still favourable since there were only two failures in the combined 67 tests. No evidence was obtained that bovine tuberculin gave better reactions than human tuberculin.

The article contains comparative data on the conjunctival and intracutaneous tests. It is shown that when a concentrated tuberculin was used reactions were obtainable in tuberculous cattle by both methods. The question of non-specific reactions in negative animals due to extraneous substances in tuberculin, e.g., glycerine, was carefully considered and the conclusion was reached that there was no substantial evidence that any serious discrepancies were liable to arise.

Arguments advanced in favour of the conjunctival test were its simplicity and the fact that repeated unequivocal reactions were obtainable within a comparatively brief period. On the other hand, slight reactions were difficult to differentiate from non-specific lacrimation due to other causes. On the whole the intracutaneous test yielded fewer failures than the conjunctival, but in the opinion of the authors in regard to

---

* 1925. Medical Research Council, Special Report Series. No. 94.

† We are not here concerned with his attitude towards the double intradermal method of testing, which he severely criticised. The objections which he raised have been answered elsewhere.

‡ M'Fadyean, J., and Sheather, A. L.

accuracy it was still inferior to the subcutaneous method since out of 124 intracutaneous tests on infected animals, 87 or 70 per cent. gave a positive result whereas with the subcutaneous method applied under similar conditions, the percentage of infection as revealed by the test was significantly higher. Nevertheless, it is admitted in the article that the subcutaneous test is by no means foolproof.

"The paramount difficulty in the subcutaneous method of testing lies in the possibility that the animal's temperature may undergo an important elevation during the period of the test from causes entirely unconnected with the action of the tuberculin. Nervous disturbance in animals unaccustomed to handling may undoubtedly cause a misleading rise of temperature, but it is probable that non-specific rises are more frequently due to other causes, the exact nature of which, as a rule, cannot be determined. These may be called accidental rises if it is understood that the word implies merely that the animal's temperature would have exhibited the observed variation even if it had not been tested with tuberculin."

"The chances of error in this direction are very great in cattle that are unaccustomed to housing and handling or which are tested in strange surroundings, but they are especially great in the case of calves and young cattle, and they are not absent in such animals even when they are not subject to any condition that would lead one to suspect irregularities of their internal temperature."

In regard to the intracutaneous test they say : —

"In our experiments this method had fewer failures than the conjunctival, but it was much less accurate than the subcutaneous. It shares with the conjunctival method the advantage that marked reactions may with little chance of error be accepted as proof of infection, but also the disadvantage that negative results are far from justifying the conclusion that the animal is non-tuberculous."

"It cannot be said that the interpretation of the results is any easier than in the case of the other two tests, the difficulty being to draw a hard and fast line between the slight transient swelling which forms at the point of injection in almost every animal and the larger and more lasting reactions which denote infection."

F.—Johne's Disease.

A survey of M'Fadyean's contributions to the advancement of knowledge on tuberculosis would scarcely be complete without some reference to his important investigations into Johne's disease. In 1895 Johne and Frothingham described a chronic form of bacterial enteritis in cattle which at first attracted scant attention. It was not until 10 years had elapsed that reports of the occurrence of a similar disease were published in Holland, Denmark, Belgium, and Switzerland. The first cases in this country were recorded by M'Fadyean who, in 1907, gave a detailed description of his microscopical findings. In this article he suggests that the terms which up till then had been employed for the condition, e.g., chronic bovine psuedo-tuberculous enteritis (Bang), etc., were unsuitable mainly because they implied some natural connection between this disease and tuberculosis. M'Fadyean introduced the term Johne's disease and by this name it is still known, at any rate in the English speaking countries. His first article is liberally illustrated with micro-photographs showing the various stages of the disease. Attention is directed to the nature of the acid-fast bacilli and the lack of any apparent relationship between the numbers of organisms and the severity of the lesions.

"If one compares these lesions with those caused by the tubercle bacillus, it is evident that the most outstanding difference is the slight intensity of the reaction which the bacillus of Johne's disease provokes. The organism apparently does not form any powerful cell poison, and hence the absence of necrosis or caseation.

On the other hand, the tissue cells appear to be almost powerless to restrain the multiplication or dissemination of the bacilli, and the lesions are therefore progressive and diffuse. The intestinal wall appears to present conditions specially favourable to the bacilli, but they are also able to multiply in the lymphatic glands attached to the intestines. It can scarcely be doubted that bacilli must sometimes be carried from these glands into the lungs and other organs, but apparently the conditions elsewhere than in the intestinal wall and mesenteric and colic lymphatic glands are unfavourable for their growth."

Five years elapsed—a short period for the study of slow growing, acid-fast organisms—and another article appeared in collaboration with A. L. Sheather and J. T. Edwards. In this paper there is to be found a detailed description of the results of tuberculin tests, the macroscopic and microscopic examination of some 19 cases and the cultural examination of tissues from a large number of affected animals. The tuberculin test, using avian tuberculin subcutaneously, proved disappointing, but some degree of accuracy in diagnosing the condition in the living animal was attained by the examination of fragments of rectal mucous membrane. In this series numerous smears were prepared from every part of the small and large intestines respectively. An estimation was made of the average number of organisms in each smear from which it was possible to construct charts showing the relative frequency of the bacilli in various parts of the intestinal tract. It is obvious that these figures can be no more than an approximation, but the information obtained was of great value as an indication of the most likely sites for the detection of the organisms.

"We do not, however, intend to convey the impression that the charts give an accurate representation of the number of acid-fast bacilli in the intestine. When smears are taken, even from adjacent places, they may vary very greatly in the number of bacilli present in them. This is well seen on looking at the charts relating to the caecum, from which organ three smears were in most cases taken."

"But in spite of all possible errors in the method of examination adopted, the charts may probably be accepted as giving a rough indication of the relative richness of the intestine in acid-fast bacilli in the different cases and also of the distribution of these bacilli in the individual cases.

"In the case of the smears from the organs and glands the rule adopted was, again, to examine fifty fields of the microscope."

The material furnished by these and other animals was also used for cultural purposes. Twort and Ingram had already demonstrated that the Johne bacillus can be cultivated on Dorset egg medium after the addition of dead human bacilli or *B.phlei*. M'Fadyean, Sheather, and Edwards carried the investigation a stage further. They experimented with a variety of substrates and found that the most satisfactory results were obtainable by the addition of glycerine extracts of acid-fast bacilli to egg or agar medium. Various types of bacilli were employed to furnish the "activating principle" but the results showed that avian strains were possibly superior to other types. The causal organism was isolated from 27 cases (23 normal and 4 experimental).

"In comparative experiments we have generally found that tubercle bacilli of the avian type gave the best results, and that human bacilli were slightly superior to the bacillus phlei. The word 'generally' has been used in the preceding sentence because absolutely uniform results are not obtainable with different lots of media prepared in the same way, and it has therefore occasionally happened that no difference could be observed between parallel cultures according as the medium contained the one or the other kind of acid fast bacillus. The most striking difference of opinion, however, has arisen in connection with the use of tubercle bacilli of the bovine type.

"As stated above, Twort and Ingram found this type of organism useless for the purpose in view, and they appear to have thought that in this fact they had discovered evidence contrary to the view that the human and bovine types are only

slightly different varieties of one and the same organism. We have found that the bacillus of Johne's disease can be cultivated, either as primary or as subcultures, on media to which bovine tubercle bacilli or extracts prepared from them have been added, and our results would not justify us in stating that in this respect the bovine type is inferior to the human type or to the bacillus phlei. And it ought to be stated particularly that our successes have been obtained with quite typical bovine bacilli, isolated directly from bovine lesions by ourselves, markedly dysgonic, and proved by experiment to be virulent for bovine animals and rabbits."

Cultures thus obtained were transferred to suitable liquid media and after a considerable amount of difficulty were induced to grow on the surface after the manner of the tubercle bacillus.

The successful outcome of the preceding experiment in obtaining cultures of the Johne bacillus on liquid medium obviously suggested the next step, namely, the preparation of a fluid similar to tuberculin. In 1916 the same three authors published the results of their tests with johnin.* The points to be decided in connection with johnin were, (*a*) whether infected animals would react in a similar way as tuberculous animals to tuberculin, and (*b*) whether the reaction was specific. The investigation was extended to study the value of avian tuberculin as a diagnostic agent. The bacilli were transferred to a broth containing a glycerine extract of Johne bacillus to supply the " activating principle." After suitable growth had taken place the liquid was filtered and concentrated by heat. A different type of johnin was also tried which was prepared by washing the organisms themselves with a 5 per cent. glycerine solution. The majority of the animals used in the test was calves artificially infected either with Johne bacillus or with one of the three types of tubercle bacillus, or with a mixture of Johne bacillus and tubercle bacilli, but a few natural cases of Johne's disease were also included. The subcutaneous, intradermal (caudal fold) and ophthalmic tests were all assayed.

The results afforded ample evidence that the substance liberated by the Johne bacillus during its growth was capable of inducing thermal and local reactions in animals affected with Johne's disease. The accuracy of these tests, however, was not of such a high order as the tuberculin test for tuberculous cattle. Good reactions were obtained in a proportion of both artificially and naturally infected animals, but similar results were also obtained with avian tuberculin. Both products were shown to be unreliable in the detection of clinical cases of the disease. The same difficulty which was experienced in the interpretation of the intradermal tuberculin test, *viz*, differentiation of the slightly positive from the negative reaction, was also encountered with the johnin test applied in a similar fashion. It is true that in some instances the positive character of the swelling was not open to doubt, but in other cases the results were regarded as indefinite. The ophthalmic test proved most disappointing.

The investigation into Johne's disease was prolonged over a period of 12 years but was completed in 1918 by an article on the histology of the lesions. This communication is comparatively short but the description of the sequence of changes which takes place in the tissues is a remarkable exposition. Briefly, M'Fadyean recognised four stages in the intestinal lesions, (*a*) the stage of cellular infiltration, (*b*) the histolytic stage, (*c*) the symplasma stage, and (*d*) the stage of giant-cell formation. Each of these

* I am not certain as to whether the introduction of this word is due to M'Fadyean, but I think that the credit belongs to him. The term " Johnin " is used in the article of 1912.

stages is described in detail and the sequence can be readily followed in the numerous carefully chosen micro-photographs.

Concluding Remarks.

There are many other important aspects of M'Fadyean's work on tuberculosis which might be touched upon if space permitted. No mention has been made of his enquiries into congenital tuberculosis, tuberculous mastitis—a subject worthy of a separate article—tuberculosis of the sheep and the cat, etc., but it is hoped that the review has given some slight indication of the fundamental and solid contributions which we owe to his untiring labours. In surveying his work liberal use has been made of extracts from the original communications. This has been deliberate and needs no apology. The writer, conscious of his own shortcomings, has preferred to draw extensively upon these articles, and has endeavoured to select those passages which would portray the spirit which animated M'Fadyean's investigations. The grace of his style coupled with his command of the English language, the accuracy of his data and the lucidity of his arguments speak for themselves and are a lasting example to all scientific workers.

THE PATHOGENESIS OF TUBERCULOSIS IN CALVES

By S. J. Edwards,
The Hannah Dairy Research Institute, Kirkhill, Ayr.

Apart from those cases of tuberculosis in the calf which have their origin *in utero*, the principal portals of entrance for the tubercle bacillus must be the respiratory and digestive tracts. It would appear to be an open question, however, which of these two channels is of greater importance in natural infection.

The available evidence in the literature regarding the role of alimentary infection in the pathogenesis of tuberculosis in calves is based on the results of direct experiments and on a study of the lesions found during *post-mortem* examination at slaughterhouses.

Very few direct experiments in which calves have been fed with milk containing tubercle bacilli have been recorded and the milk has usually been artificially infected. One such series was carried out by the Royal Commission on Tuberculosis (1907). In 22 calves which had received infected milk, it was found that the intestinal mucosa was very susceptible to infection, and ulceration was found along the whole length of the intestine. The disease did not progress, however, beyond the nearest lymphatic glands except in two calves which developed a generalised condition. The tonsils and pharyngeal glands were not frequently involved. More recently Rautmann (1935a) by feeding tuberculous milk to four calves aged 5 to 6 months found that a primary tuberculosis of the intestine and of the associated lymphatic glands was produced in those animals killed within 7 weeks. At a later stage, the disease had become generalised with secondary lesions in the tissue of the lung. Nieberle (1937) in a similar experiment with five calves found lesions in the tonsils and pharyngeal glands within 2 weeks, and in the mesenteric glands, the lung, and bronchial glands after 3 to 5 weeks.

These experiments show that when the method of infection in the calf is by ingestion the portal of entry of the tubercle bacillus is to be found in the alimentary tract, though the primary focus may assume the nature of an incomplete complex, *i.e.*, there may be no visible lesion of the intestinal mucosa.

Certain authors who have based their opinion on the pathology of the lesions found in affected calves in slaughter-houses state that infection by the digestive tract plays a minor role. For instance, Rautmann (1935b) found that of 173 tuberculous calves only 39 showed evidence of disease in the mesenteric glands. The author supports his view by the direct experiments to which reference has already been made. Nieberle (1937) found tuberculosis in 117 calves which were under 6 weeks of age. Of these, 56 (48 per cent.) showed primary disease of the liver due to congenital infection, 46 (39 per cent.) primary disease of the lungs due to inhalation, and 15 (13 per cent.) primary disease of the mesenteric glands which was assumed to be due to ingestion.

The conclusions of the direct experiments and *post-mortem* observations reviewed above are taken to indicate that (1) if infection is by the intestinal route, then the primary focus is to be found at the portal of entry ; (2) if this

evidence is accepted, then the relatively low incidence of intestinal lesions derived from *post-mortem* data would suggest that ingestion is not a common method of infection in calves.

The results of a number of the earlier investigators do not, however, support this view.

Chauveau (1868-1872), by feeding tuberculous material to calves, was the first to draw attention to the fact that the lungs and the thoracic lymph glands may be infected from the digestive tract without leaving any trace of lesions at the portal of entry. Numerous experiments which support these findings have subsequently been conducted by other workers, both on cattle and on other animals, and the literature has been fully reviewed by Calmette (1923). According to Calmette " it must be admitted that the tubercle bacilli pass very rapidly through the intestinal wall, especially during the digestion of fats, and that they neither cause lesions of the mucous membrane nor leave behind the slightest trace at the point of penetration. And these bacteria, poured with the lymph into the blood circulation may according to circumstances (number of infectious elements absorbed, degree of virulence) lead to an occult purely glandular infection, or give rise from the first to multiple grave lesions tending to localise in the lung by reason of the peculiar anatomical structure of that organ."

Recently Gofton (1937) has offered highly suggestive evidence that tuberculous lesions in calves confined to the pleural cavity are due to infection from the alimentary tract. He bases his conclusion on the relative frequency of lesions in the pleural lymph glands and on a knowledge of the common practice of calf rearing in which the calf is much more exposed to the risk of alimentary infection than to respiratory infection.

An opportunity to examine the role of alimentary infection in tuberculosis of the calf was provided in an experiment carried out at this Institute where calves were fed on milk naturally infected with tubercle bacilli. A full account of this experiment has recently been published by Wilkie, Edwards, Fowler and Wright (1937). The following is a brief summary of the experimental methods employed.

Two to three-day-old bull calves from tuberculin tested Ayrshire herds were fed on raw or commercially pasteurised milk for a period of 12 weeks. The milk was obtained from a local depot where the supply from ten untested herds was bulked, a quantity of the raw milk taken and a quantity of the same milk after pasteurisation by the holding method. Throughout the experiment samples of the raw and of the pasteurised milk were examined for the presence of tubercle bacilli by inoculating the gravity cream and the sediment of combined daily aliquots of the milk (50 ml.) into duplicate guinea-pigs twice weekly. The guinea-pigs were killed after eight weeks and a search made for the presence of tuberculous lesions.

The two groups of calves were housed in two isolated units, each consisting of two huts and strict precautions were taken to minimise the risk of conveying infection from one group to another. The calves were fed with milk heated to 100° F. from buckets fitted at their base with rubber teats; throughout the experiment the calves were fed from individual numbered buckets. No other food was given except hay from the eighth to the twelfth week of life.

At the end of the feeding trial all the calves were tested with tuberculin*

*Synthetic tuberculin obtained from the Institute of Animal Pathology, Cambridge

by the double intradermal method and, when readings were completed, they were slaughtered. A careful *post-mortem* examination was made for the presence of tuberculosis in each carcase.

Two trials were carried out, one in 1935 and one in 1936, and the results have been combined.

Results.

Infection with Tuberculosis.

In Guinea-pigs.—Forty-seven grouped raw milk samples were inoculated and the presence of viable tubercle bacilli was found in 33, or 70 per cent. Of 45 samples of the pasteurised milk, infection was not found in a single sample.

In Calves.—A total of 73 calves completed the feeding trial period and of these 36 received raw milk and 37 pasteurised milk. The

Table I.

Pasteurised-Milk Fed Group.				
	Tuberculin Tests.			
Calf No.	*First Reading 48 hour mm.*	*Second Reading 72 hour mm.*	*Reaction.*	*Organs Affected with Tuberculosis.*
1	7	10	—	None.
5	7	8	—	,,
9	7	8	—	,,
11	7	8	—	,,
13	6	7	—	,,
15	7	9	—	,,
17	6	7	—	,,
19	6	6	—	,,
21	5	5	—	,,
23	5	6	—	,,
25	32	37	+	No lesions found, negative results from guinea-pig inoculation of glandular material.
29	6	7	—	None.
31	7	7	—	,,
35	7	10	—	,,
37	6	7	—	,,
43	6	7	—	,,
41	8	8	—	,,
A 1	6	6	—	,,
A 3	5	6	—	,,
A 5	5	6	—	,,
A 7	5	5	—	,,
A 9	5	6	—	,,
A11	5	5	—	,,
A13	6	6	—	,,
A15	5	6	—	,,
A17	4	6	—	,,
A19	7	7	—	,,
A21	7	8	—	,,
A23	5	6	—	,,
A25	6	6	—	,,
A27	5	6	—	,,
A29	5	6	—	,,
A31	5	6	—	,,
A33	4	5	—	,,
A35	5	6	—	,,
A37	5	6	—	,,
A39	5	6	—	,,

TABLE I (*continued*).

Raw-Milk Fed Group.

Tuberculin Tests.

Calf No.	*First Reading 48 hour mm.*	*Second Reading 72 hour mm.*	*Reaction.*	*Organs Affected with Tuberculosis.*
4	6	8	—	None.
6	6	7	—	„
8	7	8	—	„
10	26	34	+	Bronchial glands.
12	24	30	+	Bronchial glands, ant. lobe left lung.
14	7	8	—	None.
16	30	32	+	Bronchial glands, ant. lobe left lung.
18	6	7	—	None.
22	5	5	—	„
26	18	22	+	Bronchial glands.
28	50	55	+	Bronchial glands, ant. lobe both lungs.
30	7	8	—	None.
34	6	9	—	„
36	7	10	—	„
38	6	7	—	„
40	25	28	+	Bronchial glands, ant. lobe right lung.
44	7	9	—	None.
A2	5	6	—	„
A4	10	16	+	Bronchial glands, ant. and mid. lobes both lungs.
A6	22	19	+	Bronchial and mediastinal glands.
A8	18	19	+	Bronchial glands.
A10	24	30	+	No lesions revealed in naked-eye search.
A12	17	18	+	Bronchial and mediastinal glands, ant. and mid. lobes both lungs. Pleurisy.
A14	20	24	+	Bronchial glands.
A18	24	28	+	Bronchial and med astinal glands. Pleurisy.
A20	12	18	+	Bronchial and mediastinal glands. Lungs.
A22	16	14	+	Bronchial and mediastinal glands.
A24	10	20	+	Bronchial and mediastinal glands. Lungs—all lobes involved.
A26	20	22	+	Bronchial glands, mid. lobes both lungs.
A28	22	20	+	Bronchial glands, ant. and mid. lobes both lungs.
A30	18	22	+	Bronchial glands, mid. lobes both lungs.
A32	21	26	+	Bronchial glands, ant. and mid. lobes both lungs.
A34	22	26	+	Bronchial glands, mid lobe left lung.
A36	22	24	+	Bronchial and mediastinal glands, mid. lobe right lung, ant. lobe left lung.
A38	15	16	+	Bronchial and mediastinal glands, mid. lobe left lung.
A40	22	20	+	Bronchial glands, mid. lobe right lung.

results of the tuberculin test and the *post-mortem* findings are shown in Table I.

It will be seen that the results in the calves serve to verify those obtained in the guinea-pigs. Thus, of the 36 calves fed on raw milk 24 reacted to the tuberculin test and with one exception (calf No. A10) *post-mortem* examination showed the presence of tuberculous lesions. On the other hand, only one calf (calf No. 25) in the pasteurised-milk fed group reacted to the tuberculin test but a careful search failed to detect any lesions in this calf. Furthermore, the presence of tubercle bacilli was not demonstrated by inoculating glandular material from this calf into guinea-pigs. With the exception of these two anomalous results the tuberculin test was confirmed by the *post-mortem* findings in the remaining 71 calves.

The nature of the reaction to the tuberculin test is worthy of comment. In those animals which were free from disease the double injection did not give rise to more than a small pea-like induration, whereas in the majority of the affected calves an intense reaction characterised by a diffuse œdematous swelling of the skin was evident 48 hours after injection. This marked degree of skin sensitivity to tuberculin is probably explained by the fact that the allergic state is highly developed at a stage when tuberculous lesions are newly formed.

The *post-mortem* findings in the tuberculous calves will be referred to in the discussion.

Discussion.

The results of the guinea-pig tests, in which grouped daily samples of the milk fed during the experiment were examined, showed that the calves in the raw-milk fed group were receiving milk which was highly contaminated with tubercle bacilli. Consequently, it might have been expected that evidence of primary infection would be found in the digestive tract or in its associated lymphatic glands. But, as will be seen in Table I it was found at the *post-mortem* examination that the tuberculous lesions were entirely confined to the organs of the pleural cavity. Thus, among the 23 affected calves lesions of the lungs and of the thoracic lymphatic glands were found in 17, while in the remainder the mediastinal and/or bronchial glands alone were affected. Careful naked-eye examination of the mesenteric glands of all the affected calves, however, failed to show the presence of lesions, and similarly the pharyngeal glands of six calves showing extensive lesions of the pleural cavity were also unaffected. The experiment in which these observations were made was not primarily intended to study this pathogenesis of tuberculosis in the calf and for this reason microscopic examination was not made of various tissues. Nevertheless, the lesions in the pleural cavity were in such an advanced stage that if lesions had been present in other sites they ought to have been detected by naked eye examination in some of the affected cases. It might be suggested that the presence of pulmonary lesions in some of the calves was

caused by respiratory infection since the animals were not housed separately. The method of infection in at least one calf in each hut must, however, have been by ingestion and it is not unreasonable to assume that all the other calves were similarly infected. Furthermore, the method of feeding the milk by allowing the calves to suck rubber teats would tend to obviate the possibility of direct respiratory infection due to the aspiration of small quantities of milk. Again, at the end of the 12 weeks feeding period, the tuberculous lesions of the lymphatic glands were for the most part enlarged and caseated and in some calves they had reached the calcified stage—a feature which is in accord with an infection acquired at an early stage of the experiment.

The findings of this experiment, where calves were continuously fed on naturally infected tuberculous milk, must be taken to support the contention of those authors quoted by Calmette. In the first place they substantiate the view that the localisation of lesions in the pleural cavity need not necessarily point to infection *via* the respiratory tract. In the second place they indicate that infection by the alimentary tract plays an important role in the pathogenesis of tuberculosis in the calf. It follows, therefore, that when attempts are being made to eradicate tuberculosis, an essential part of the programme is the provision of a safe milk supply for calf rearing. This experiment shows, incidentally, the remarkable effectiveness of pasteurisation in dealing with milk highly contaminated with tubercle bacilli.

Summary.

(1) A brief review is given of the literature concerning alimentary infection in the pathogenesis of tuberculosis in calves.

(2) Following the feeding of infected milk to 36 calves over a period of twelve weeks, 23 showed lesions of tuberculosis when slaughtered. On the other hand, 37 calves receiving the same milk after pasteurisation were not affected.

(3) The lesions in the diseased calves were confined to the pleural cavity and the significance of this finding in relation to the method of infection is discussed.

My thanks are due to Dr. F. C. Minett and to Dr. J. Wilkie for their collaboration in the *post-mortem* examinations.

References.

Calmette, A. (1923). Tubercle bacillus infection and tuberculosis in man and animals. (Baltimore, Williams and Wilkins Company).

Gofton, A. (1937). *Edinburgh Med. J.*, **44**, 333.

Nieberle, K. (1937). *Arch. wiss. prakt. Tierhlk.*, **71**, 323.

Rautmann, H. (1935a). *Tierärztl. Rdsch.*, **41**, 529.

——. (1935b). *Ibid.*, 367.

Royal Commission on Tuberculosis. (1907). *2nd Interim Rep.*, App. II, 499.

Wilkie, J., Edwards, S. J., Fowler, A. B., and Wright, N. C. (1937). *J. Dairy Res.*, **8**, 311.

A BRIEF NOTE ON TUBERCULOSIS IN TROPICAL AFRICA WITH SPECIAL REFERENCE TO UGANDA

By J. Carmichael, d.sc., m.r.c.v.s., dip.bact. (lond.).
Senior Veterinary Research Officer, Entebbe, Uganda.

Introduction.

It is perhaps not inappropriate on such an occasion as this to give a brief survey of the investigations which have been carried out on tuberculosis during the past 4 years in Uganda, inasmuch as Sir John M'Fadyean was one of the earliest workers in Great Britain on this disease. His investigations into tuberculosis in animals and his insistence on the importance of the bovine organism are too well known to need elaboration in an article such as this. I have not referred specifically to the literature on the subject but mention should be made of Cochrane's recent paper, " A Survey of Tuberculosis in the Tropics " [*Tropical Diseases Bulletin*, 1937, **34,** 743-772, 819-836.] where a comprehensive list of references may be consulted. The Annual Reports of the Veterinary Departments in the various African Dependencies reveal the present position with regard to tuberculosis in so far as it is known.

General.

Tuberculosis of both man and animals in tropical countries is a subject which has received comparatively little attention from scientific workers, mainly because their efforts have naturally been directed to the more drastic and rapidly fatal diseases which occur in epizootic or enzootic forms throughout the warmer regions of the world. The very insidiousness of tuberculosis has accounted for this apparent neglect, but there seems little doubt that the disease has been quietly progressing for many years both in man and animals, whilst the attention of the authorities concerned has been focused on matters of more immediate urgency.

Jameson (1934) as a result of a tour in the East to investigate public health problems concludes that " tuberculosis is just as serious a killing disease in many parts of the tropics as it is in Europe." Investigations even now point to the fact that tuberculosis is not by any means a new disease to the tropics, and that neither man nor his domestic animals constitute that " virgin soil " in which the tubercle bacillus can seed itself, flourish and destroy whilst encountering the minimum of resistance.

As far as Uganda is concerned, there is a considerable variation both in the morbidity rate and the mortality rate in different tribes of peoples and in different types of cattle. The relation between man and his domestic animals in the tropics is much closer than in temperate climates. In many parts of Africa, the home is shared

with goats, sheep, fowls and often cattle, whilst even the most primitive hygienic precautions are conspicuous by their absence. The stage is set for easy and rapid dissemination of tuberculosis should the disease assert itself.

Investigations in Uganda are being carried out under the following main headings :—

(*i*) The incidence of tuberculosis in cattle and other animals ; typing of strains.

(*ii*) Investigations into the susceptibility of the Zebu type of cattle as compared with other breeds of cattle.

(*iii*) The isolation and typing of strains of human origin.

Tuberculosis in Animals.

Cattle.—Save as calves, cattle in Uganda are housed only under rare circumstances such as sickness or as a tribal custom originating from the days of raiding, as occurs in some of the Bagishu areas in Uganda. Normally, cattle live entirely in the open air and are herded together at night in a kraal or a circle of thorn bushes as a protection from wild beasts. It is surprising, therefore, that tuberculosis should present itself as a problem at all if conditions as generally accepted in Europe are necessary for the existence and spread of the disease. It has been established that the long-horned Hamitic cattle belonging to the Bahima people of Ankole are infected with tuberculosis to a degree far in excess of any known in the worst regions of Europe ; yet these animals roam over open, dry down-like country with a rainfall of approximately 30 inches per annum and are never housed except as calves or in the event of sickness. The general morbidity rate in Ankole cattle as revealed by the tuberculin test (double intradermal) may reach 80 per cent., whilst the slaughter-house returns give the incidence of infection with tuberculosis as over 40 per cent.

In considering the high infection rate in Ankole cattle, it is interesting to compare the figures with those recorded from Zebu cattle in Uganda. In this class, tuberculin tests show a very low reaction rate (below 1 per cent.), whilst the meat inspection returns confirm this state of affairs as indicated by the tests. The difference in natural incidence of infection thus revealed in two types of cattle in the same country inevitably raises the question of the relative susceptibility, which will be discussed later, of these types.

Tuberculosis in Sheep and Goats.

Sheep and goats almost invariably share the hut with the human occupants so that, apart from its interest *per se* tuberculosis in these animals raises a public health question of immediate importance. Twelve cases of the disease have been investigated in sheep, all from the Ankole area, and eleven of these proved to be caused by organisms of the bovine type. The other case was one of spontaneous fatal generalised tuberculosis from which the human strain of tubercle

bacillus was isolated. This animal died on a Government stock-farm and unfortunately the previous African owner could not be traced.

Eleven cases of tuberculosis in goats have been investigated and all were due to the bovine type of organism.

The Susceptibility of Zebu and Ankole Types of Cattle.

It has been pointed out that the incidence of tuberculosis is very high in the long-horned Ankole type of cattle whilst in the humped Zebu animals cases are very infrequent.

This apparent immunity of Zebu cattle to tuberculosis has been noticed in India many years ago, and the investigations of Edwards, Sheather, Sopakar and others are well known. All through Equatorial Africa, where the Zebu type of cattle predominates, bovine tuberculosis is rare, and the question arises, as it did in India, whether there is not some specific race resistance to infection with tuberculosis in these cattle. Some 30 strains of tubercle bacilli have been isolated from Ankole and Zebu cattle and all have proved to be bovine strains of standard virulence. The infecting organism at all events appears typical. Investigations are still being pursued with the important object of determining whether any race resistance exists.

Strains of Tubercle Bacilli from Human Sources.

The vast majority of cases of tuberculosis in African natives in Uganda are pulmonary in character and thanks to the co-operation of the Director of Medical Services some 240 specimens of tuberculous sputum from various tribes have been or are being examined and the strain of organism isolated and typed. So far only four of these have yielded bacilli of the bovine type, and although there is a history of contact with cattle in each case none of the specimens were from the pastoral Bahima tribe who live an almost symbiotic existence with the highly tuberculous Ankole cattle. The presence of bovine phthisis in the human subject, however, has been established, and the percentage infection in these unselected cases is comparable to that discovered in Great Britain and emphasises the importance of other than human strains in the epidemiology of tuberculosis in the African native.

I would like to record my great appreciation to Mr. W. F. Poulton, C.B.E., Director of Veterinary Services, Uganda, and Dr. W. H. Kauntze, C.M.G., Director of Medical Services, Uganda, for their assistance and co-operation over the past four years without which these investigations could not have been accomplished.

BOVINE TUBERCULOSIS AND ITS CONTROL

Editorial Articles written for this Journal (Vol. 12) by Professor J. M'Fadyean in the year 1899, i.e., Seventeen years after the publication of Koch's discovery of the Tubercle Bacillus, i.e., in 1882.

THE STAMPING OUT OF TUBERCULOSIS.

As time advances, and information regarding the prevalence of the disease is accumulated, the difficulty, not to say the impossibility, of eradicating tuberculosis from among the domesticated cattle of this country becomes more and more apparent. The difficulty of diagnosis, which before the discovery of tuberculin [1890], stood as an insuperable barrier to stamping-out measures, has now almost entirely disappeared, but a new and equally great obstacle has been brought to light in the discovery that about one-third of the adult animals of the bovine species in Great Britain are already affected with tuberculosis. In support of this estimate, it may be mentioned that during the past two years particulars relating to the testing of 4,379 cattle have been communicated to the Editor by members of the veterinary profession practising in various parts of England and Scotland, and that out of that number 1,389, or 31·7 per cent., reacted. As with few exceptions the animals tested were apparently healthy, there does not appear to be any ground for believing that if the whole of the breeding cattle in the country were tested the proportion of them found to be affected would be much less.

The discovery that about one-third of the breeding stock of the country are already affected with tuberculosis has made it impossible for any sane person to maintain that the Board of Agriculture ought to schedule tuberculosis under the Diseases of Animals' Act, and proceed to apply to it the measures which were successful in stamping out cattle plague and foot-and-mouth disease, but plans which are scarcely more rational are being urged upon the Government by some of their irresponsible advisers. An example of these crude, ill-considered schemes is furnished in a paper by Mr. Hunting which appears in a recent number of the *Journal of the Society of the Arts*.*

Mr. Hunting recognises that if 20 per cent. of our adult cattle are infected, and we assume that all these animals must be slaughtered and partially paid for, "we enter on an undertaking that neither the owner of stock nor the taxpayer would approve." But he thinks "there is no necessity for such wholesale slaughter," and he proceeds to unfold the following plan for dealing with the disease.

"The majority of infected cattle are not infective to others—they are neither dangerous to man nor other animals, and their slaughter would be a wicked waste. Only the visibly affected are dangerous, and their number does not exceed 40,000. This estimate would include every animal whose carcase is wholly unfit for human food and every cow whose milk is unfit for consumption.

"The slaughter of these would be a loss to the owners, but it would be a public benefit, and it is expedient and just that the public should share the loss.

"I suggest that Local Authorities should pay as compensation £2 per head for all compulsorily slaughtered of a value not exceeding £8; and a sum equal to one-fourth the market value of all others seized—but no animal should be valued at over £24. Any salvage on carcases, minus the cost of removal and slaughter should be repaid to the owner.

"The payment of £2 as compensation for miserable animals that are a danger to man or to other stock may seem an illogical proceeding, but unless some such inducement is offered, many of them would be sold to the lowest class of butcher and find their way into human food. A payment of £2 per head would make it worth the while of the owner not to evade reporting to the authorities, and so the existence of disease would become known with greater expedition. Infected premises once recognised could be supervised in such a way as to assist the owner and protect the public.

"Compensation at the rate of £2 for all animals below the value of £8, and compensation at a higher rate on all over that value would probably reach a cost of £100,000 in the first year and a constantly decreasing sum every year afterwards until no disease existed. This is less than is now paid every year for the attempts to stamp out swine fever.

"For this payment what should we receive? A guarantee against human infection from animals, and a gradual but rapid suppression of disease among stock."

*January 27th, 1899.

It is doubtful whether anyone aspiring to guide public opinion on the tuberculosis question has ever offered such ill-judged advice, or made a forecast which is so absolutely unjustified by knowledge and experience. Here we are told that only visibly tuberculous animals are dangerous, and that the slaughter of such animals, coupled with compensation to their owners, would lead to a rapid suppression of the disease. Furthermore, that the money required for compensation would probably be £100,000 during the first year, and less each succeeding year " until no disease existed." Now, if there is one well-ascertained point in connection with the subject of tuberculosis among cattle, it is that the disease cannot be stamped out by the simple and comparatively inexpensive method of slaughtering the animals that develop clinical symptoms of the disease. The idea to the contrary is so obviously erroneous that an apology is almost necessary for taking the trouble to refute it.

Mr. Hunting estimates that in the course of a year only 40,000 animals would require to be slaughtered on account of external indications of tuberculosis, and this, calculated on the basis of the most recent returns of the number of cattle in the United Kingdom, represents one animal for every 126 of the cattle population. Otherwise stated, Mr. Hunting supposes that tuberculosis could be rapidly suppressed by the slaughter, on an average, of one animal annually in every third or fourth lot of cattle in the country, for the average number of animals in the possession of the same owner probably does not exceed 40. One is prompted to wonder why, if the matter is so simple as this, there is any call for the intervention of the State, at least, so far as the interests of cattle-owners are concerned. Alas, that it should not be true that only every third or fourth farmer or cowkeeper in this country has in the course of a year as much as one clinically tuberculous animal.

One is tempted to think that some people spend so much of their time in the excogitation of what may be termed fancy methods of dealing with tuberculosis that they have no time to look into the recorded experience of those who have been practically applying themselves to the eradication of the disease. Hundreds of farmers and veterinary surgeons can testify to the practical impossibility of stamping out tuberculosis from among housed cattle by the slaughter of the visibly affected, and tuberculin has revealed to many an astonished owner that 20 or 30 per cent. of his animals are tuberculous although for years previously he had not lost a single animal from the disease, or had any reason to suspect its existence in his herd. Nor does this by any means state the full measure of the difficulty of stamping out tuberculosis. Centuries of the operations recommended by Mr. Hunting would not suffice to stamp out tuberculosis, and even when resort is had to tuberculin, and every animal that reacts is killed or isolated, a clean bill of health is not always immediately obtainable. If anyone doubts this, he may be referred to the often-cited experiments of Professor Bang in Denmark. Take, for example, the results of the attempts to eradicate the disease from the farm of Thurebylille. Here the whole herd was first tested in the spring of 1892, and all the animals that reacted—not merely the visibly diseased, as in Mr. Hunting's plan—were promptly removed to a separate compartment. Twice annually after that, for 5 years, the tuberculin test was applied to what was called the " sound section," and on each occasion any animals that reacted were removed. What was the result ? The eighth, ninth, and tenth tests revealed respectively seven, seven, and six cases of tuberculosis ; in other words, 5 years of this system had not sufficed to eradicate the disease. In face of this experience, how can anyone with a reputation to lose pretend that tuberculosis could be stamped out by merely killing the visibly diseased animals ?

To tell farmers that " only the visibly affected are dangerous," is to seek to propagate a most dangerous error. What requires to be impressed upon them is that the disease may be spread by an animal that appears to be perfectly healthy, and that, therefore, every animal that reacts to tuberculin must be considered dangerous, if the object is to obtain a clean bill of health.

But it may be said that if ten applications of the tuberculin test at half-yearly intervals to the apparently healthy animals, followed on each occasion by the removal of those that react, will not eradicate the disease, the ultimate advantage would not counterbalance the trouble and expense. It is probable, however, that the object in view may be obtained in much less than 5 years. As indicated elsewhere in this number, the tuberculin test is not infallible, and to guard against the possibilities of error, it ought to be repeated at shorter intervals than 6 months, at least, during the first year.

We do not agree with Mr. Hunting in thinking that tuberculosis can be stamped out by the slaughter of the visibly diseased animals, but for another reason we consider that it is time that the law took cognisance of clinical symptoms of tuberculosis in cattle. In the forefront of such symptoms stands tuberculous disease of the udder.

Since our last issue the Local Government Board have issued an order amending Article 15 of the Dairies, Cowsheds and Milkshops Order of 1885, so as to provide that for the purposes of paragraph (*a*) and (*b*) of that Article reference to disease shall include, in the case of a cow, such disease of the udder as shall be certified by a veterinary surgeon to be tubercular. This is no doubt a step in the right direction, but it is a very halting and inadequate step, since in the case of large towns which draw their milk supply mainly from outside sources it will leave the dangers arising from the sale of milk from tuberculous udders practically untouched. Tuberculous disease of the udder, or, better still, every disease of the udder of a milch cow, ought to be made notifiable, and the sale of milk from a diseased udder ought to be forbidden under a penalty. For reasons which we have explained in former articles, we are also of opinion that the sale of milk from an animal that is obviously tuberculous in any part of the body should be prohibited, and that notification of obvious signs of tuberculosis in a milch cow ought to be made compulsory. These measures are necessary as reasonable safeguards to the milk-consuming public, though their introduction cannot be urged on the ground that they would ever suffice to stamp out tuberculosis.

IS THE TUBERCULIN TEST INFALLIBLE?

"Is the tuberculin test infallible?" is one of the questions frequently asked by those who contemplate having their cattle tested. If the answer has to be monosyllabic it must be "No." No agent in human hands can be said to be infallible for any purpose, and although with the exercise of proper precautions the tuberculin test is marvellously reliable, it is not absolutely free from the chance of error, as the following considerations will show.

In the first place, tuberculin is not a substance of definite chemical composition and strength. It is obtained by cultivating tubercle bacilli in an artificial nutrient liquid, and its efficacy as a test depends upon certain substances of ill-defined chemical composition which are added to the liquid by the vital activity of the bacilli growing in it. As regards their mode of origin, these substances may be compared to the alcohol which is formed in a saccharine solution in which one of the yeasts is cultivated. Tuberculin would be termed weak or strong according to its richness in these substances, and it is a test for tuberculosis because a quantity of it which produces no appreciable effect on a non-tuberculous animal excites a short but sharp attack of fever, manifested mainly by a rise of temperature, in one that is tuberculous. But by using a sufficiently large quantity of tuberculin one may cause the temperature to rise in an animal that is free from tuberculosis, and by using too small a dose of tuberculin, or a tuberculin that from some error in its manufacture is too weak, one may fail to cause an elevation of temperature even in a tuberculous animal.

These facts alone may appear to carry with them serious chances of error, but as a matter of fact, the risks of miscarriage which they involve are inconsiderable, provided the tuberculin is obtained from some reliable source, for there is already a large experience to guide those who manufacture it as to the proper dose, and there is fortunately a wide margin between the quantity that will excite a reaction in a tuberculous animal and the quantity that will cause the temperature to rise in a healthy one.

Another possibility of error arises from the fact that one has to measure the reaction to tuberculin by the elevation of the animal's temperature during the 15 or 18 hours after the injection of the substance, and that during this period the temperature may rise from some cause quite unconnected with the injection of tuberculin. This, again, may at first sight appear to provide serious risk of errors in diagnosis, but there is a circumstance which reduces it to very small proportions, *viz.*, the fact that the reaction to tuberculin is measured not entirely by the *amount* of the elevation of temperature, but also by the *manner* in which the temperature ascends. The normal temperature of the ox is from 101° to 102° F., and when a tuberculous animal of that species is tested with tuberculin its temperature begins to ascend a few hours afterwards, and *gradually* rises two, three or four degrees, the maximum point being reached about the 12th or 15th hour, after which it gradually falls again to the normal. Every rise which has this character must be taken as an indication that the animal is tuberculous, but sudden ascents of temperature followed by sudden falls to the normal must be set down to some accidental disturbance. The subjoined temperatures of two animals under the test will make this plain, the first showing the gradual ascent of a tuberculous animal, and the second an erratic rise determined by an accidental disturbance.

No.	*Time of Injection.*	3 *Hours.*	6 *Hours.*	9 *Hours.*	12 *Hours.*	15 *Hours.*
1	101·8°	102·4°	103·4°	106·6°	105·8°	105·2°
2	102°	101·6°	102·2°	101·7°	101·7°	105·8°

It will thus be seen that one is able to recognise a good many accidental rises of temperature in animals under the test, and thereby to avoid the mistake of classing the animals in question as tuberculous, but it must be confessed that no amount of care can altogether evade the chances of error from this cause, and in certain circumstances these become very considerable. That is notably the case in animals that have been exposed before or during the test to excitement, such as is occasioned by transporting them to strange surroundings. On this account it has already been abundantly proved that the test is not to be relied upon when carried out on cattle in a market or slaughter-house. Wherever possible, cattle should always be tested in their own premises, and if they have experienced a change of quarters, the operation ought to be postponed until observation with the thermometer has shown that the temperature has become quite normal and steady. The complaints regarding uncertainty and errors in the application of the test to valuable animals sold for export are probably ascribable to neglect of this very necessary precaution.

The foregoing are possibilities of error in the direction of diagnosing tuberculosis in healthy animals, which is probably regarded by most people as the most objectionable mistake that can be made in carrying out the tuberculin test, but there is also a chance of error of the opposite kind, that is to say, of passing a tuberculous animal as healthy. Obviously this is a very unfortunate mistake to make, for it may lead to the introduction of the disease into a previously healthy herd, or it may nullify the sacrifice which an owner has made in disposing of all the animals that have reacted, with the object of eradicating the disease from his stock.

Mistakes of this kind probably sometimes arise from an oversight in performing the operation, part or whole of the dose of tuberculin escaping between the hypodermic needle and the nozzle of the syringe, perhaps owing to some sudden movement of the animal at the moment of injection. Obviously, with the exercise of proper care, this ought to be a very rare accident. There is, however, one chance of error in this direction which is less easily avoided. It appears to be a very well established fact that an animal with actual tuberculous lesions in it will react to tuberculin, but between the moment of infection and the formation of actual lesions in the part to which the bacilli have gained access—the lungs for example—a certain time must elapse. Infection with the bacilli, whether by inhalation or ingestion, may be momentary, but it is not credible that an animal infected in the forenoon would react in the afternoon of the same day. The period of time that must elapse after infection before a reaction can be obtained is as yet undertermined, and possibly it varies according to the method of infection. The point is one of considerable importance, and the following experiments bear upon it. A steer which gave no reaction to tuberculin was infected by the injection of living virulent tubercle bacilli into one of its veins. Nine days afterwards, when tested with tuberculin, its temperature gradually rose from 101·4° until at the twelfth hour it had reached 105·3°, after which it gradually declined. A heifer which did not react was infected in the same manner, and when re-tested 8 days afterwards it displayed a typical reaction, the temperature rising gradually to 105°. The test was repeated 10 days later, and with a similar result.

It ought to be observed that in these cases a large number of bacilli were used to infect the animals, and it probably would not be safe to conclude that a reaction would be obtained as soon after natural infection by the inhalation of a few bacilli. To counteract this source of error it is advisable, when an attempt is being made to weed the disease out of a herd, to re-test those which have not reacted on the first occasion after an interval of not more than 3 months.

Lastly, among the possible errors that may be made in using tuberculin, there must be included the occasional failure to elicit a distinct reaction in animals which are emaciated and near the point of death from tuberculosis. This, however, cannot be considered a serious defect in the use of tuberculin, for such failures are only met with in animals that are worthless, and whose tuberculous condition is almost obvious.

It will be seen from the foregoing considerations that the tuberculin test is not one in which the possibility of error is absolutely excluded, but when the sources of error are known beforehand they may be guarded against, and a most trustworthy indication as to the existence or non-existence of tuberculous disease in the animal tested may be obtained.

VETERINARY INSPECTION OF MILCH COWS.

The recent Order of the Local Government Board giving Public Health Authorities power to prohibit the sale of milk from cows affected with tuberculous disease of the udder has given fresh importance to the question of veterinary inspection of dairies and the means by which tuberculous mastitis may be diagnosed in the living animal. It is gratifying to learn that in several boroughs arrangements for a periodic inspection of all the dairy cows within the boundaries by a qualified veterinary surgeon have already been made, with a view to the detection and elimination of cases of tuberculous disease of the udder. This is, no doubt, a step far short of what many people have demanded, and we have already expressed the opinion that more extended powers are necessary to enable large towns which draw their milk supply mainly from outside sources to prevent the sale of unwholesome milk. Nevertheless, if full advantage is taken of the new Order the sale of milk from cows affected with mammary tuberculosis may be made much more difficult than it has been hitherto.

The first question which arises in connection with the exercise of the powers conferred by the new Order is, how frequently is it necessary to have the udders of milch cows inspected in order to guard against the sale of tuberculous milk? This is a question not easy to answer. It may safely be asserted that the shorter the intervals between the inspections the better, but a limit to the frequency of inspection is placed by the expense thereby incurred. On this account it would be useless to recommend inspection at shorter intervals than a fortnight, and at first many authorities will probably be content with less frequent examinations, but if any substantial benefit is to be obtained from the exercise of the powers conferred by the Order the interval between the inspections should certainly not exceed one month. In this connection, it must be remembered that no obligation to report cases of tuberculous disease of the udder is laid upon the owner of cows, and that no penalty for the sale of tuberculous milk can be inflicted so long as the sale has not been prohibited on the certificate of a veterinary inspector to the effect that the animal in question is affected with tuberculous disease of the udder. Had notification been made compulsory, and the sale of milk from a cow with a visibly diseased udder been forbidden under a penalty, there would have been less occasion to insist upon a frequent veterinary inspection of dairy cows.

The second question arising out of the new Order relates to the means by which tuberculous disease of the cow's udder may be diagnosed while the animal is still alive. According to our present knowledge the characters which serve broadly to distinguish tuberculous mastitis from other diseased conditions of the udder are: (1) that it is always insidious in its onset, (2) that its course is always chronic, (3) that it never ends in resolution, (4) that it steadily adds to the volume and density of the invaded quarter, and (5) that at the outset of an attack the milk is not notably altered either in quantity or appearance.

It has been stated that tuberculous disease of the udder has sometimes a comparatively sudden development, and a semi-acute course. This is probably an error if it implies that a previously healthy gland may within a few days develop a tuberculous lesion so gross as to be readily detected by manipulation. There is no reason to suppose that tuberculous disease proceeds with much greater rapidity in the udder than in other organs such as the lung or a lymphatic gland, and both natural and experimental cases teach that a period of weeks rather than days elapses between the infection of an organ and the development of macroscopic lesions in it.

The insidious onset of tuberculous mastitis is a character valuable for diagnosis, and at the same time one which renders the disease peculiarly dangerous. When a reliable clinical history is obtainable to the effect that within the course of a day or two a previously healthy quarter has become considerably enlarged, and when this enlargement is associated with the usual signs of acute inflammation—an abnormally high surface temperature, congestion of the superficial vessels, and tenderness on pressure—it may safely be concluded that the lesion is not of a tuberculous nature. By this means a great many cases of udder disease can immediately be dismissed when only tuberculous mastitis is being sought for.

The commonly occurring non-tuberculous cases of mastitis develop rapidly with the before-mentioned accompaniments of acute inflammation, and in the great majority of such cases the affected quarter begins to shrink as the acute inflammatory phenomena subside. This is also a very valuable point for diagnosis, and it enables one to put aside all those cases in which a cow has only three active quarters, with a fourth which yields little or no milk and is abnormally small in size. On the other hand, a quarter that is larger than its fellow of the opposite side, and indurated without tenderness, must always be provisionally diagnosed as tuberculous.

Stress has, by some authors, been laid on the condition of the supramammary

lymphatic glands as a guide to diagnosis, but, as a rule, in actual practice, very little information is derivable from that source. In the early stages of lactation in cows with large fleshy udders, it is often quite impossible to ascertain the conditions of the glands, and they may escape detection even when they are considerably enlarged. Besides that, the glands are generally more or less enlarged in all forms of inflammation of the udder, at least, while the disease is in an active stage.

A less constant character of tuberculosis of the udder than those previously noted is invasion of the quarter from above downwards. The great majority of acute inflammations of the gland begin around the milk cistern, at the lower part of the quarter, but the whole quarter speedily becomes involved, and at the time when such cases come under observation it is impossible to trace how the disease began. On the other hand, one often encounters cases of tuberculous mastitis with marked enlargement and induration at the upper part of the quarter while a portion of the gland over the base of the teat is still of the normal size and flaccidity. It is true, however, that tuberculous disease of the udder sometimes appears to begin at the lower part of the quarter.

The character of the induration in tuberculous mastitis deserves special attention. The nodular character of tuberculous lesions in the other organs commonly affected, such as the lungs, liver, and serous membranes, is apt to lead one to expect a similar condition in tuberculosis of the udder. As a matter of fact, however, the disease in the udder is seldom tuberculous in the anatomical sense, for instead of a number of well-defined nodules or tubercles embedded in comparatively sound gland tissue, one usually finds a single diffuse indurated area shading gradually into the surrounding flaccid tissue of the udder.

A negative characteristic of tuberculosis of the udder which is of some value for diagnosis is that the lesion has little or no tendency to soften, and seldom or never bursts spontaneously through the skin. On the contrary, the lesion generally becomes firmer with age, and sometimes acquires an almost stony hardness from calcification.

In the generality of non-tuberculous inflammations of the udder, and always in those of an acute character, the milk is from the outset profoundly altered in character and amount. It is usually purulent, curdy, or ropy in consistence, and frequently it is more or less deeply tinged with blood. The amount of secretion that can be drawn off through the teat is always diminished. In tuberculosis of the udder, on the other hand, the lacteal secretion may not be sensibly altered in appearance or quantity at a time when the lesion has attained considerable dimensions and is easily detectable by manipulation. In the later stages, however, when the greater part of the quarter has become involved in the disease, the secretion is greatly diminished in amount and quite abnormal in appearance. Such liquid as can then be drawn off is generally whey-like in colour, and on standing it deposits a considerable amount of sediment. It ought to be observed, however, that similar appearances may be presented by the milk in the late stages of the acute non-tuberculous inflammations.

Probably the most constant of the characteristics of tuberculous disease of the udder is the presence of tubercle bacilli in the milk of the affected quarter. Unfortunately, this character is of less value for clinical diagnosis than it might at first sight appear to be. It is only exceptionally that the bacilli occur in the milk in such numbers as to make it practically impossible to overlook their presence when a properly prepared cover-glass preparation is examined with a suitable microscope, and if it were made a rule that the disease must not be diagnosed except when tubercle bacilli can be demonstrated microscopically in the milk condemnation would in many cases have to be dangerously delayed. Nevertheless, in every case in which the clinical characters of the udder disease raise a suspicion of the lesion being tuberculous the milk ought to be microscopically examined. Ought such examination to be undertaken by the veterinary surgeon? The answer to that is that there is no reason why he should not, provided he has by practice assured himself of his ability to detect tubercle bacilli in any product in which they are present in considerable numbers. He must be equipped with a good bacteriological microscope, comprising an oil-immersion lens, and magnifying 800 diameters. Any slaughter-house will provide him with abundance of material on which he may exercise himself in staining tubercle bacilli by the Ziehl-Nielsen or other approved method, and detecting them with the microscope. When he has confidently mastered the technique of this process, he need not hesitate to apply the same methods to the discovery of tubercle bacilli in milk.

During the advanced stage of tuberculous mastitis, when the milk has become markedly altered in appearance, a competent person will seldom fail to detect the

bacilli in the first few cover-glass preparations examined. At this stage, the milk on standing generally deposits a considerable amount of sediment rich in leucocytes and other cells from the udder, and this is the material that ought to be selected for miscroscopic examination.

As long as the milk furnished by the suspected quarter is comparatively normal in appearance and quantity it is a great advantage to have a small centrifugal machine, by means of which the cream may quickly be obtained from a sample of milk and any solid particles in it that tend to precipitate may with equal rapidity be thrown down. It has been stated by some observers that in centrifugalised or separated milk the bacilli are mainly or entirely found in the thin milk or in the sediment. This is certainly not the case when the milk is still normal in appearance and fairly rich in cream, for the bacilli are then carried up in considerable numbers with the milk globules, and are often more readily found in the cream than in the remainder of the sample. Probably the safest plan is to stain preparations from both the cream and the sediment. In the absence of a centrifugal machine, the sample of milk to be examined may be allowed to stand for 12 hours or more in a conical glass vessel until the cream has risen and any solid particles have fallen to the bottom.

When tubercle bacilli are found in milk that has been taken with precautions that exclude the risk of accidental infection no room is left for doubt as to the diseased condition of the udder, but it must not for a moment be supposed that failure to detect tubercle bacilli with the microscope, even when the search has been a prolonged one, justifies one in concluding that the udder is not tuberculous, or that tubercle bacilli are not present in the milk. One may add tubercle bacilli to milk and then dilute it to such a degree as to make the detection of the bacilli in it with the microscope almost impossible except by spending an unreasonable amount of time in the search. Nevertheless, such diluted milk remains infective if used in sufficient quantity, and although the danger is no doubt less in proportion to the degree of dilution, one cannot admit that milk is fit for human food when it contains only a few tubercle bacilli.

The considerations just referred to raise an important question, *viz.*, what is the duty of a veterinary inspector entrusted with the powers conferred by the recent Order of the Local Government Board when in the case of a cow with an enlarged, indurated, and painless quarter he is unable to demonstrate the presence of tubercle bacilli in the milk ? We think that he ought not to hesitate to diagnose tuberculosis of the udder in such circumstances, and by so doing give the human consumer of the milk, rather than the cow, the benefit of the doubt. In such a case, however, the diagnosis and the suspension of the milk may be made provisional, until the cow can be tested with tuberculin, or until the milk can be tested by experimental inoculation. It may be objected that the tuberculin test cannot be employed to determine whether a given lesion of the udder is tuberculous or not, since a reaction merely indicates that there is tuberculous disease in some part of the animal's body. In spite, however, of the force which lies in this objection, it is worth while to employ the test in doubtful cases of this kind, for, in the first place, it may show that the animal is not tuberculous anywhere, and thus remove the suspicion that attached to the udder, and, in the second place, in the event of a reaction being obtained in a cow whose udder is clinically tuberculous, the fact must be allowed some weight in considering whether the animal ought to be condemned for milk purposes.

In all cases that remain doubtful after clinical and microscopical examination, inoculation experiments may be employed, the use of the milk being in the meantime suspended. This is beyond any doubt the most delicate test for the presence of tubercle bacilli in milk, but little need be said with regard to it here, since experiments of this kind are illegal on the part of those who do not possess a vivisection licence, and because for their successful employment facilities which are not usually at the command of the ordinary practitioner are required.

There is, however, one point connected with the testing of milk by inoculation experiments to which it is fitting to call attention here—namely, the necessity of collecting the sample to be tested in such a way as will avert the chance of error from accidental contamination of the milk with tubercle bacilli after it has left the cow's udder. With this object it is necessary to cleanse and disinfect the teat and the hand used for milking, and to collect the milk in a clean, sterile bottle. In this connection, it may be observed that when milk taken as it leaves the farm or dairy is found to be infective by the delicate test of experimental inoculation, it does not follow that the herd of cows furnishing the milk in question contains an animal with tuberculous disease of the udder. The sediment which common market milk too frequently deposits on standing is mainly composed of excrement and other dirt from the cow's udder or from the air of the cowshed, and matter of that kind derived from premises containing a large proportion of tuberculous cows may add tubercle bacilli to milk that is quite wholesome as it leaves the gland.

SIR JOHN M'FADYEAN'S WORK ON "LOUPING-ILL"

By W. A. Pool,

Deputy Director, Imperial Bureau of Animal Health, Weybridge.

Perusal of the English veterinary literature of the closing years of the last century indicates clearly the extent to which Sir John M'Fadyean towered above his contemporaries. At a time when medical science was settling down to a revolutionary development concerning the causation of disease many of those in responsible positions were unable to grasp the principles involved. Some hindered progress by their ill-informed enthusiasm, which led to the acceptance of mere saprophytes as the cause of disease; while others raised querulous objections to the recognition of logically planned experimental work that pointed to the incrimination of real pathogens or to the elimination of factors vital to indefensible extant theories.

Ill-informed criticism is often very difficult to refute and the struggles of Sir John M'Fadyean as a pioneer to prove that the new methods of investigating disease were sound deserve the sympathy of modern scientists.

The investigation of "louping-ill" illustrates the position in this respect. The laity was of course not well-informed and unsuitable scientists were often selected to undertake investigations, and the academic positions of the latter were sometimes considered to give weight to their defective arguments.

When M'Fadyean published his first report on "louping-ill" in 1894 the work of Williams, then Principal of the New Veterinary College, Edinburgh, and that of Klein, was very prominent.

Klein failed to apply clinical observations to his studies and examined sheep that were obviously affected with disease other than "louping-ill." He refused to believe that ticks were related to the transmission of the disease and elaborated a theory that the cause was a soil organism. To his credit he did not incriminate any organism obtained from affected sheep.

Williams's work was hampered by his ignorance of bacteriology, and, at that time, knowledge of the life cycle and biology of the tick concerned was unsatisfactory.

In 1896 and in 1897 Meek and Greig Smith published work on "louping-ill," and suggested that certain soil organisms were inoculated into sheep by ticks in the course of sucking the blood. These authors were obviously handicapped by their ignorance of veterinary science, and their bacteriological work was lamentable. Even so they received considerable support in the North of England.

M'Fadyean returned to the subject in 1900. His two papers give a clear and accurate account of the disease, and although they did not reveal its nature they indicated the lines along which further investigation should be undertaken.

In 1906 the report was published of the Departmental Committee appointed by the Board of Agriculture to investigate the disease and in 1915 McGowan published a monograph on the subject. Those responsible for both publications failed to take advantage of the information provided by M'Fadyean and made fundamental errors that were not to be expected at those times.

When the cause was finally elucidated nearly thirty years after M'Fadyean's last publication on the subject, of all the earlier authors he had given the clearest and most accurate account of the disease. All the unnecessary complication introduced by other authors was absent and the statements were as true as when they were written.

The "louping-ill" controversies of the eighteen-nineties provide a splendid object lesson on the defects of clinical observation made without experimental investigation, and there is often evidence at the present day that clinicians could be reminded with advantage of the moral that might well be drawn from these experiences.

LAMB DISEASES COINCIDENT WITH LOUPING-ILL*

By W. Lyle Stewart and A. Phyllis Ponsford,

King's College, Newcastle-upon-Tyne.

Nineteenth century writers on louping-ill, with one notable exception, were unanimous in ascribing to the disease a remarkably complex and variable train of symptoms, well illustrated by the words of Fair, written in 1839: ". . . The disease does occasionally assume so many different forms, although each is more or less connected and allied with the other, that the most skilled veterinary practitioners may for a while be puzzled to say whether it (louping-ill) is most akin to tetanus, apoplexy or palsy." The notable exception was Sir John M'Fadyean, who in 1893 visited Northumberland at the request of the Royal Agricultural Society of England to obtain first-hand information about louping-ill. Sir John published an account of his observations in this journal the following year. The disease had interested laymen and certain professional men for perhaps a hundred years, but no definite progress towards its better understanding had been made, and gradually the term louping-ill became enveloped in a haze of conjectures, assertive claims, and contradictions. In Sir John's brilliant article, however, we see the mind of the master, assessing the data obtained from careful observations and searching *post-mortem* examinations, anxious to neglect no relevant fact, and clearly determined not to be sidetracked into accepting such parts of the traditional views as could not be tested by precise experiments. The result was that Sir John's work on louping-ill succeeded in crystallising some order out of chaos, and may be considered, as already noted by Pool, to have marked the starting point of rational investigations into the nature of the disease.

Sir John found that the term louping-ill was not applied to a single well-defined pathological entity, but included a variety of diseases causing deaths among ewes and lambs, particularly in May and June. Sir John said:—

"Without attempting to decide which of them has the best claim to the name, I feel warranted in saying that the following are the principal morbid conditions at the present time grouped under the head of louping-ill.

"(1) Pyæmic spinal meningitis, caused by pyogenic bacteria.

"(2) Gastritis and enteritis from indigestible substances (wool, sand, dried grass) in the stomach or intestines.

* Received for publication on the 21st December, 1937.

"(3) Disorders of brain functions, paralysis and general weakness, excess of cerebro-spinal fluid in the cranial cavity, but without gross lesions in any of the organs in the body.

"The first two of these conditions cover most of the cases of louping-ill in lambs, and the third includes the bulk of the cases in adult sheep."

Sir John isolated a micrococcus from the pyæmic lesions in lambs and adduced experimental proof that this micro-organism was responsible for the pyæmic condition, but was unable to determine the cause or causes in the third of these groups of cases.

During the last few years the writers have had occasion to enquire more closely into the causes of death amongst young lambs on tick-infested pastures in Northumberland, and the results of this work show a close parallel with those obtained by Sir John over forty years ago. It is abundantly clear that even now the general term louping-ill includes such diverse diseases as tick-borne infections, digestive disorders, certain braxy-like diseases, and true louping-ill, and consequently specific prophylactic measures directed against the louping-ill virus, discovered as the causative agent of true louping-ill by Pool, Brownlee and Wilson in 1930 will be followed by satisfactory results only on those farms where there is a high incidence of this infection. Differential diagnosis is therefore important.

Recent Investigations.

In December, 1936, our advice was sought in an effort to improve the lamb crop on a tick-infested farm in Tynedale where we were informed that 100 to 150 lambs were lost annually from alleged louping-ill. In order to test the usefulness of louping-ill vaccine as compared with serial anti-tick dippings on this particular farm, the following experiment was planned and carried out with the assistance of a grant from the Royal Agricultural Society of England. Louping-ill vaccine was employed on one hirsel and serial dippings with a variety of anti-tick dips were used on the adjoining hirsel.

Minor sub-divisions were made as follows :—

A.—*Vaccinated hirsel.* (1) Ewes vaccinated early in March and lambed on tick-infested pastures.

(2) Ewes not vaccinated but dipped prior to lambing and moved to tick-free enclosure. Lambs vaccinated soon after birth.

(3) Ewes vaccinated as in Group I and dipped prior to lambing on tick-free enclosure. Lambs vaccinated soon after birth.

Groups 2 and 3 were returned to the tick-infested pastures ten days after lambing.

B.—*Dipped hirsel.* Three different tick deterrent dips were used and compared in this hirsel. It was planned to dip the ewes just before lambing and to dip both ewes and lambs twice thereafter at intervals of three weeks.

During the lambing season, all dead lambs, excluding lambing casualities from obvious causes, were retained for *post-mortem* examination.

RESULTS.

A.—Vaccinated Hirsel.

Group.	*No. of Ewes.*	*No. of Lambs Alive, May 7th.*	*Deaths in Lambs to June 18th.*	*Causes.*	
1	Vaccinated, 198	Not vaccinated, 178	25 (14 per cent.)	Pyæmia	11
				Grass-ill	6
				L. dysentery ...	2
				Susp. L.-ill ...	1
				Indefinite	5
					25
2	Not vaccinated, 138	Vaccinated, 124	17 (14 per cent.)	L. dysentery ...	5
				L.-ill (susp.) ...	4
				Pyæmia	3
				Grass-ill	3
				Indefinite	2
					17
3	Vaccinated, 37	Vaccinated, 35	3 (9 per cent.)	Pyæmia	2
				L. dysentery ...	1
					3

On June 18th 292 lambs were marked. These were the produce of 373 ewes representing a lamb crop of 78 per cent., or only 1 per cent. better than the average for the preceding four years, and 12 per cent. below the 90 per cent. mark, which is regarded as a good average for hill flocks and allows for five barren ewes and five lamb casualties per cent. The chief single cause of death among the lambs was found

B.—Dipped Hirsel.

Group.	*No. of Ewes.*	*No. of Lambs Alive, May 7th.*	*Deaths to June 18th.*	*Causes.*	
1	135	108	7 (6 per cent.)	Effects of Dip ...	3
				Grass-ill	2
				Pyæmia	2
					7
2	118	85	25 (23 per cent.)	Pyæmia	18
				Effects of Dip ...	3
				Louping-ill... ...	1
				Indefinite	3
					25
3	176	132	22 (16 per cent.)	Pyæmia	14
				Grass-ill	3
				Effects of Dip ...	2
				Louping-ill.... ...	1
				Indefinite	2
					22

to be pyæmia, which accounted for 16 deaths out of a total loss of 45 lambs. The *post-mortem* findings show clearly that louping-ill vaccination is scarcely indicated, and this view is borne out by the failure of this treatment to improve the lamb crop. It will be noted that only five cases of true louping-ill were suspected.

Owing to adverse weather the serial dippings were not carried out according to programme, except in Group I, and for this reason, a strict comparison of the dips is not possible. It is of interest to note, however, that in 1936 the death rate among the lambs comprising Group I amounted to 20 per cent. as against 6 per cent. in 1937.

The chief point which emerges from the above figures is that out of 99 lambs examined *post mortem* 50 were affected with pyæmia, and clinical or suspected louping-ill was encountered in only seven lambs, four of which had been injected at birth with louping-ill vaccine. It may be concluded, therefore, that improvement in the net lamb crop on this farm depends largely on the successful control of pyæmia, true louping-ill amongst the lambs being of no great economic importance.

Heavy losses amongst lambs were also reported from sheep farms in another tick-infested valley in Northumberland, and a preliminary investigation was undertaken in June, 1936. It was found that although braxy-like diseases evidently killed a proportion of the lambs during May and June, yet pyæmic infections were responsible for death in quite as many cases. In May, 1937, therefore, it was decided to establish a field laboratory in this valley under the ægis of the Braxy-like Diseases Sub-committee of the Agricultural Research Council in order to investigate the relative importance and inter-relationship of these diseases. Arrangements were made to collect, as far as possible, all dead lambs from these farms and convey them daily by car to the laboratory, where they would be submitted to a detailed *post-mortem* examination. It was not possible, however, to submit each brain to a biological test for the louping-ill virus, as attention was concentrated on the two major diseases.

In 15 days in May, 1937, 110 lambs were received and examined.

At *post-mortem* the presence or absence of ticks was noted, and whether or not abscesses were present on the skin or in the internal organs. Blood smears were made from the heart blood and spleen and stained with Gram and Giemsa stains. Cultures were made in duplicate from heart blood, kidney, intestinal contents, liver and peritoneal fluid. One of each was heated to 65° C. for 15 minutes while the other was incubated unheated. After incubation all cultures were stored for later, more detailed work. The spleens were detached and weighed. In some cases the brains and spinal cords were exposed. Intestinal contents were collected and tested for toxicity. According to consistency a variable amount of normal saline was added and the mixture centrifuged for 1 hour at 3,000 r.p.m. The supernatant fluid was inoculated intravenously into mice, duplicate tests being carried out for

each sample. Doses of 0·4 and 0·2 c.c. were administered, and if the intestinal contents proved toxic, then attempt was made to block the toxic principle with antisera of *Clostridium welchii* Types A, B, C, and D, and occasionally of *Cl. septique*. In cases where Type D and *septique* antisera failed to protect, a mixture of Types C and D was also administered. In all cases antisera remained in contact with the test fluids for half-an-hour at room temperature before injection.

Result.

	Cases.
Pyæmic infections alone	30
Cl. welchii Type D infection alone...	18
Pyæmic infections plus *Cl. welchii* Type D infection... ...	20
Lamb dysentery	5
Incidental deaths (known causes)	9
Suspected tick-borne fever	5
Indefinite	23
Total	110

Pyæmic infections varying in severity were encountered in 50 lambs and were believed to be responsible for death in 30 cases. Intercurrent infection with *Cl. welchii* Type D had evidently killed the remaining 20.

Of the total 38 cases of *Cl. welchii* Type D infection only 18 were free from pyæmic lesions, and this casts some doubt on the shepherds' belief that the biggest and healthiest lambs are most susceptible to so-called grass-ill (anærobic infections). As already explained, tests for true louping-ill were not carried out, and a number of the undetermined deaths may have been due wholly or in part to this virus.

Discussion.

During his short visit to Northumberland in May, 1893, Sir John M'Fadyean found that pyæmic spinal meningitis or alimentary disorders covered most of the cases of so-called louping-ill in lambs, and our extended observations in 1937 have shown that Sir John's views are still substantially correct. Of the 209 lambs examined after death on tick-infested pastures pyæmic infections were noted in 100 cases, and in all probability were the cause of death in 80 cases. The causal micro-organism corresponds closely with the micrococcus described by Sir John, *i.e.*, it is Gram positive, occurs frequently in pairs, tetrads and in irregular groups and is slightly chromogenic. It will be noted that the pyæmic cases examined by Sir John showed mainly spinal meningitis. The site of the fatal lesions, however, is probably fortuitous, and in addition to infection of the meninges our work now shows that death may occur from pyelo-nephritis, adhesions of the heart, lungs and liver to the diaphragm, peritonitis, pleurisy or verrucose endocarditis. Since the pyæmic lesions were clearly of many days' standing without causing

noticeable symptoms, it is evident that the disease is insidious in its onset and runs a chronic course, producing death only when the function of a vital organ is seriously impaired. Affected lambs are frequently severely crippled and may then succumb to exposure. Apart from direct losses from pyæmia there is a possibility that this infection lowers resistance to intercurrent disease since, as already pointed out, 20 of the 38 cases of *Cl. welchii* Type D entero-toxæmia examined in one district revealed more or less extensive pyæmic lesions.

In the light of more recent knowledge and our 1937 investigations, it is possible that the deaths from "louping-ill" described by Sir John as due to gastritis and enteritis resulting from the ingestion of wool, sand and dried grass, may actually have been due to infection (*Cl. welchii* Type D).

Of the 110 cases submitted to a full examination, 68 (62 per cent.) revealed pyæmic or *Cl. welchii* Type D infections. Since other incidental causes of death were diagnosed in 19 cases (17 per cent.) it is clear that true louping-ill can, at the very most, have been responsible for the 23 indefinite cases (21 per cent.). It is probable, however, that at least some of these indefinite cases were due to occult pyæmic lesions or undetermined entero-toxæmias.

Thoroughness and accuracy characterise all good investigational work, the value of which remains undiminished with the passing of time. Sir John M'Fadyean displays these qualities in high degree, and his early writings in many fields may be read to-day with profit. It must be as rare as it is pleasant to look back on an investigation carried out over forty years ago and feel assured that no vital observation was missed and no unwarranted conclusion drawn.

POX IN PHEASANTS

By N. Dobson, B.SC., M.R.C.V.S.,

Senior Research Officer, Veterinary Laboratory, Ministry of Agriculture and Fisheries.

History of Outbreak.

An outbreak of disease occurred in pheasants which were being reared in woodlands. The age of the birds varied from 4 to 10 weeks. When the outbreak came to be investigated, the disease had been in progress about a fortnight, and during that period more than 400 birds had died. Owing to the thick nature of the undergrowth, the birds were difficult to catch, but at feeding time 40 were collected for examination. The birds presented a very miserable appearance, standing about moping in isolation until they were approached, when they ran away into the shrubberies. The shoot had been in existence a few seasons, but this year extra ground had been rented and a large amount of rearing was being carried out on it. Some of the eggs were from the home supplies, but large numbers had been purchased and hatched under hens.

Enquiries showed that the new ground had been used in the immediately preceding season for pheasant rearing by another owner and that a large death rate had occurred. It was impossible to find out the nature of the disease which had occurred during the previous season. The woodlands closely adjoined the hall farm, and from the previous rearing season fowls from this farm had had free access to the ground, until the present outbreak of disease was noted in the pheasants, when they were excluded. These fowls did not belong to the owner of the pheasants and it was not known whether any were diseased or not.

The hens used for hatching the pheasant eggs were all examined before use and stated to be free from lesions of fowl pox. Examination of these birds at the time of the outbreak showed no lesions in the usual sites and all of them were in good condition. Many of the sick pheasants were examined, killed, and brought to the laboratory for investigation.

Symptoms.

The birds were obviously sick, wings drooping, and many showed the eyelids of one eye closed. Sneezing and coughing were very noticeable.

Post-mortem Examination of the Pheasants.

In all the birds examined the conditions were very constant. The nostrils were closed with a small quantity of dried material, the removal of which revealed a thick pale yellow discharge. Pressure

over the upper portion of the nasal cavity caused the discharge to be exuded. There was a swelling in some of the birds in association with the infraorbital sinus. Examination of the mouth showed in some birds no lesions, whereas in others a pale yellow diphtheritic deposit was present on the dorsal and ventral surfaces of the tongue, and on various parts of the mucous membrane of the mouth, similar small lesions were present. Examination of the upper air passages disclosed a partially dried cheesy yellow material, more of which was found in association with the swelling below the eye. In a few cases lesions were found in the pharynx and cranial larynx. The remainder of the respiratory system showed no lesions and the remaining organs of the body were normal. No lesions were found in any specimen on the skin of the body, legs, or wings.

Experiments.

Material was collected from the mouth, nasal cavity, etc., triturated, and inoculated into birds. Five fowls, two one-week-old chickens and ten pigeons were used. The combs of the fowls were scarified and some of the suspension applied by swabbing the area. Small quantities of the emulsion were injected into the nasal passage of the chickens, and some applied to the plucked breasts of the pigeons, which had been lightly scarified.

Small lesions of fowl pox occurred on the combs of the fowls. The two chickens showed no lesions of the mouth or visible parts of the nasal cavity, but died before they could be tested for immunity. The pigeons developed good lesions, the scab formation drying normally and in 6 days commencing to separate from the underlying tissues. Material was collected from the fowls and pigeons for further passage.

The following day a group of two fowls and ten pigeons were inoculated in exactly the same manner as at the first passage. Good lesions developed on the combs of the two fowls, but unfortunately all the pigeons died within 6 days from the date of inoculation.

From two of the dead pigeons, the liver and bone marrow were collected, triturated and filtered through a Seitz disc. The filtrate was applied to the scarified breasts of twelve pigeons. All these pigeons showed good reactions and a large quantity of material was collected from them. The material from the fowls was further passaged in fowls and the material from the pigeons passaged in pigeons, each to the 6th passage.

The pox lesions on the combs of the fowls increased in size; one bird of the 5th passage developed an extremely large crust-like lesion over the entire surface of one side of the comb, which had been lightly scarified. The lesions of generalisation on the wattles and the mouth and tongue were all well developed.

The material from the pigeons was available in larger quantity than from the fowls and was employed in an attempt to infect pheasants.

In the absence of a comb in the pheasant, the mouth parts and the skin of the leg were used as the sites of inoculation. A suspension of material from the pigeons was prepared and applied to the lightly scarified mucous membrane of the mouth and a small area of the leg (from which the feathers had been removed) of ten adult pheasants. All the pheasants reacted, and two developed good mouth lesions. Material was collected from the mouth parts and legs of these two birds and applied to the scarified combs of fowls.

In 8 days good reactions were present in these birds and the crusts were collected.

Ten pheasants were vaccinated with pigeon pox vaccine on a scarified area of the leg, from which the feathers had been removed. The vaccine produced a good reaction in all the birds and one month later they were all inoculated with virulent pheasant material *ex* pigeons, applied to a scarified area on the other leg. Careful examination failed to show any pox lesions following this inoculation. One month later these birds were re-inoculated, intravenously and by scarification of the mouth with virulent pheasant material from the pigeons. Six pheasants showed small lesions of pox in the mouth, which did not tend to increase in size, but quickly healed. One bird had lesions on the mouth parts and around the eye which quickly healed. The three remaining birds showed no lesions.

Three pheasants which had not been vaccinated with the pigeon pox vaccine were used as controls. These were inoculated intravenously and by scarification of the mouth with virulent pheasant material *ex* pigeons. These three birds developed extensive lesions on the tongue, hard palate, on the mucous membrane of the mouth generally, and around the eye. The lesions on the skin near the eye were the typical crusty pox lesions as seen on the comb or wattle of a fowl. Some of these lesions were present 2 months after they had commenced to develop.

Two months after these pheasants had been inoculated, they were transferred to another run and immediately six susceptible fowls were scarified on the comb and mouth parts and placed in the contaminated run vacated by the pheasants. No cleaning or disinfection of the house or run was carried out prior to the introduction of the fowls. The fowls were examined at regular intervals but no lesions of pox were found. One month later these fowls were scarified on the comb and inoculated with pheasant virus and in 7 days all showed good pox lesions.

Three vaccinated pheasants were lightly scarified on the mucous membrane of the mouth, but no virus was applied to the parts, and placed in a run with affected pheasants. The birds were examined on the 6th day following scarification, and subsequently at regular intervals for a period of 2 months and no lesions of pox were found.

Five hens placed in a separate house were scarified on the comb and inoculated with pheasant material *ex* pigeons. Well marked lesions of pox developed. The complete area of one side of the comb was in several birds covered with one confluent scab.

Material collected from the 12th passage in fowls was used to inoculate a group of pigeons, but the resulting lesions were very small, whereas the control fowls gave good reactions on the comb.

Discussion and Conclusions.

1. From these findings it will be seen that an outbreak of pox in pheasants was confirmed.

2. With the virus it was possible to infect pheasants, fowls and pigeons artificially. Liver and bone marrow from pigeons artificially infected with the pheasant strain were passed through a Seitz filter and when the resulting filtrate was inoculated into susceptible pigeons, characteristic lesions of pox developed.

3. Virus obtained from the pheasants when inoculated into the

fowl and pigeon caused typical pox lesions in these birds. This is contrary to the usual findings. The literature contains many references to the difficulty of artificially infecting pigeons with fowl pox virus, but it is known that fowls are susceptible to the artificial infection with pigeon pox virus.

When first inoculated into fowls and pigeons the virus under investigation produced good reactions in both these species. On further passage in fowls, the lesions on the scarified combs increased in size; one fowl at the 5th passage developed a large, thick, crusty lesion over the entire surface of one side of the comb. In pigeons the virus was inoculated by scarification of the plucked breasts, and on serial passage produced good lesions. At the 12th passage in fowls transference of the virus to the scarified breasts of pigeons resulted in the development of only very small lesions.

Doyle and Minett[1] state: "It seems that when pigeon virus is passed through a fowl it undergoes some change which prevents it being readily transmitted back to the pigeon."

Bierbaum and his colleagues[2] state: "It appears there are pox strains which are specifically pathogenic for the fowl and the pigeon, but that there are also strains which are pathogenic, possibly in a varying degree, to both species of birds."

From the behaviour of the pheasant virus in these experiments, it appears that this virus is neither a fowl nor a pigeon strain, but one more closely related to the pigeon than the fowl strain.

Pheasants vaccinated with pigeon-pox virus showed a normal reaction such as is seen ordinarily in the fowl. One month later these pheasants were inoculated on the skin of the leg with virulent pheasant pox and failed to show any lesions.

It will be seen therefore that used as a vaccine the pigeon-pox virus produced a valuable immunity against the strain of virus under investigation.

References.

[1]Doyle, T. M., and Minett, F. C. (1927). *J. Comp. Path. & Ther.*, **40**, 255.
[2]Bierbaum, K., Eberbeck, E., and Kayser, W. (1931). *Arch. wiss. prakt. Tierhlk.*, **64**, 20-28; *Vet. Bull.* (Abst.) 1932, **2**, 152-3.

RINDERPEST: A RESUMÉ OF RECENT PROGRESS IN EAST AFRICA

By R. Daubney,
Director of Veterinary Services, Kenya Colony.

Although it is not strictly speaking an entirely tropical or sub-tropical disease, economically rinderpest is undoubtedly the most important disease in tropical Africa and Asia, and the communication by Curasson and Delpy, 1926, of their success in applying the inactivated tissue-vaccine method of immunisation marked the opening of a new era in the control of this disease. The fact that Kakisaki (1918) in Japan and Boynton (1918) in the Philippines had been employing this method of immunisation for some time was unknown to most workers, and Curasson's publication was the first on this subject to appear in Western literature. In East Africa Hornby (1928) and Daubney (1928) published reports of studies on the rinderpest virus, the latter including records of experimental and field immunisations by the tissue-vaccine method. Since that time a good deal of work has been carried out on tissue vaccination against rinderpest in East Africa, and a new method of control of the disease has been evolved from the early laboratory experiments. It has been shown that amounts of inactivated spleen tissue as small as 1 gramme may be large enough to protect high-grade cattle against subsequent inoculation of from 2,000 to 5,000 minimal infective doses of virus, when the immunising tissue, taken from a reacting animal of high susceptibility, has a virus content of from 20,000 to 50,000 minimal infective doses per gramme, and that a higher degree of immunity is evoked if even this small dose is divided into two halves which are given at an interval of from 7 to 14 days. Following a single injection of vaccine containing 4 grammes of spleen tissue, immunity will begin to wane after about 15 months ; but when a total of 6 grammes of tissue is given in two weekly doses immunity may persist for more than 2 years. When the same quantity of tissue is given in three equal weekly injections a few animals have been found to retain an almost complete immunity 4 years and 3 months later (Daubney, 1934 and unpublished results). It is our experience that by this method the more susceptible breeds of cattle (*e.g.*, European breeds) are more readily immunised than more resistant breeds. A further point of interest is that the immunity provoked by a course of three injections of vaccine can be reinforced and maintained at a high level by single injections of vaccine repeated each year. The figures relating to the duration of immunity apply to adult animals only ; they are less applicable to yearling animals, and not at all to calves, which appear rapidly to outgrow their immunity. The last remark refers equally to calves born of susceptible mothers and to the progeny of

immune cows, and is quite independent of any passive immunity that may have been transferred to the calf *via* the milk.

As a method of state control vaccination has been in force over an area of some 7,000 to 8,000 square miles in Kenya during a period of nine years. The use of vaccine has been entirely voluntary, and most farmers have neglected to vaccinate their cattle until rinderpest has appeared in the district. In spite of this, and in spite of the annual use of virus in the immunisation of cattle on certain farms in the northern part of the area, there were only 49 outbreaks in the area during the 4 years 1933-36, and during 11 months of 1937 there have been seven outbreaks only, of which six had a common origin. The area in question encloses extensive forest and mountain ranges inhabited by buffalo and other large ruminant game, but in the absence of infection in the cattle the game in the centre of the area has entirely escaped infection, although twice the disease has been introduced by buffalo with the creation of numerous foci of infection within and near the periphery of the area. It is quite evident to anyone who has watched the progress of events in this field experiment that rinderpest can be eradicated from any closely-settled area by compulsory annual vaccination and simple control of outbreaks.

The vaccine-virus method of immunisation has been developed from the original experiments with slightly infective vaccines. Daubney (1933) has published records of long-term immunity tests made on animals vaccinated (*a*) with a single dose of infective vaccine (formalin 1 1,500) and (*b*) with a dose of completely inactivated vaccine followed by a dose of infective vaccine. The testing of random samples drawn at intervals of 12½ to 15, 32 and 63 months showed that method (*b*) evoked a significantly higher degree of immunity, and that by this method animals might be protected against severe reaction and or death for periods in excess of 5 years. Further experiments made in 1932 to 1935 on a group of 1,200 cattle showed that if one desires to immunise animals permanently by an injection of vaccine followed by an injection of virus, it is necessary to provoke a high percentage of reactions to the virus inoculation. The desired result can be achieved by balancing the doses of virus and vaccine, but the more certain method is to employ a fairly large dose of vaccine and a large vaccinating dose of virus. This is the practice that has largely been followed for a number of years in certain parts of Kenya Colony. It is to be emphasised that so far no entirely risk-free method of provoking a permanent immunity against rinderpest, which at the same time is 100 per cent. effective, has yet been discovered, and that it is unlikely that such a method ever will be available. If one is determined that no single animal shall escape complete immunisation one must narrow the margin of safety either by decreasing the protective dose of serum or vaccine, or by increasing the infective dose of virus quantitatively or qualitatively to the point at which some mortality will probably occur : one works in fact on a threshold level with all its attendant risks.

In the search for an inexpensive infective method of immunisation attention has been centred on possible methods of producing a variant of attenuated virulence for bovines. Schein (1924, 1926) and Edwards (1929) were the first to revive interest in the method of serial goat passage as a possible means of attenuation, and Edwards' attenuated goat virus (Muktesar) has been extensively employed in the immunisation (without serum or other passive protective agent) of the more resistant Indian plains cattle. Apparently the Muktesar strain showed evidence of attenuation for bovines after as little as 30 passages, but the field work carried out in India subsequent to Edwards' laboratory experiments has until recently been insufficiently documented. In Kenya we have been able to compare the virulence of the Muktesar virus with our standard Kabete bovine strain, and with an attenuated variant of this strain produced by goat passage. Inoculated alone to grade and native cattle in Kenya the Muktesar virus has provoked a mortality of approximately 18 per cent. Reactions and mortality are, however, easily controllable by the use of a small simultaneous dose of serum or a previous dose of vaccine. In a recent experiment 100 cattle were inoculated with vaccine (1 gramme of tissue) and 14 days later with 2 c.c. of a 2 per cent. suspension of infected goat spleen tissue. Eighty-five of the animals reacted to the goat-virus inoculation, and although there was a noticeable loss of condition, no mortality occurred. These animals completely resisted a further virus inoculation—this time with 2 c.c. of fully virulent 10 per cent. bovine spleen suspension given 2 months later. Nine of the animals failed to react to the goat virus, three animals failed to react to either of the virus inoculations, and three reacted to the goat virus and subsequently exhibited doubtful reactions to the bovine virus. There was no mortality.

Our general experience is that animals that have reacted to the Indian goat-virus—whether partially protected by passive means or not—do not again react to our standard Kabete virus; but in a recent test of 22 animals double-inoculated with goat virus and serum, five animals that had reacted to the double-inoculation reacted (three of them clinically) to a test dose of bovine virus given 27 days later. It is just possible that these unexpected reactions may in reality be exacerbations of unusually prolonged reactions from the first inoculation, and that they are caused by the second inoculation of virus having been administered too soon. The chief apparent disadvantage of goat virus is the variability of goat spleens in respect of virus content; some of the spleens contain more than 50,000 minimal infective doses for cattle per gramme, while others may fail to induce reactions in 100 per cent. of inoculated animals when a dose of 0·02 gramme is employed. This difficulty can be countered by the pooling of several spleens and the testing of a bulked batch of suspension, provided a satisfactory method of preservation can be worked out, and we propose to attempt the storage of frozen desiccated tissue. The spleen of an ox, killed at the height of its

reaction to Muktesar goat virus, contained more than 50,000 minimal infective doses of virus, and the virus appeared to be unchanged so far as its virulence for bovines was concerned: here is another promising source of material for vaccinations.

A recent series of passages of the stock Kabete bovine strain of virus in goats has given interesting results. The virus was rapidly adapted to the goat and soon reached the stage of causing 100 per cent. mortality in this species. Taken back to cattle at the 12th, 18th, 24th, 31st, 41st and 48th passages it produced death in 9, 8, 8, 7, 8 and 9 days respectively. From the 69th to the 80th passages four inoculated cattle died in 16, 14, 12 and 13 days. At the 85th passage the first recovery occurred, and from then on to the 150th passage 15 animals recovered and only two died. There was a gradual suppression of the more serious symptoms from the 85th passage onwards—mouth lesions became transient and finally disappeared, conjunctivitis was next greatly reduced, the nasal discharge became less profuse and anorexia was observed for 2 or 3 days only. The last symptom to disappear was the diarrhœa, but the reduction in severity of the rinderpest reaction was accompanied by an increase in the tendency of animals to break down to coccidiosis in the later stages of the reaction. In the later passages pharyngitis is absent, gastritis greatly reduced in severity, and what lesions are present in the alimentary tract are in the main confined to the large intestine.

In view of our ability to produce variants of the virus by prolonged serial passage in goats, it seems highly probable that similar variants may also be produced by serial passage in tissue culture, particularly if the embryonic tissues of species normally insusceptible or only slightly susceptible to the infection are employed. In two series of observations at Kabete the virus has been carried through three, four and five passages in bovine, caprine and rabbit tissues, and there is little doubt that in the near future it will be successfully maintained in cultures over a long series of passages. It is in this direction that we should look for a cheap infective form of vaccine which will enable governments to effect eradication of rinderpest from less closely administered countries by universal inoculation of stock over a period of years.

The virus of rinderpest does not appear to be pantropic and all attempts to produce a neurotropic variant have failed. Rabbits, mice, guinea-pigs and goats have been used in these attempts, and an extensive series of inoculations has been made in the last-named species employing the technique of Mackenzie, Findlay and Stern, in which the inoculated animal is passively protected against visceral multiplication of the virus by an injection of hyperimmune serum. The virus has only rarely survived the few days occupied by the first intracerebral passage and has never been detected at the second passage.

References.

Boynton, W. H. (1918). *Philippine J. Sci.*, 39.

Curasson, G., and Delpy, L. (1926). *Bull. Soc. Central Vet.*, 297.

Daubney, R. (1928). *J. Comp. Path. & Ther.*, **41**, 228.

——. (1929). *Bull. No. 8, Dept. Agric. Nairobi, Kenya*, 1934, 1935, 1936.

——. (1933-6). *Ann. Reps. Dept. Agric.*, Kenya.

——. (1936). *Rep. Conf. on Co-ordination Vety. Research*, Kabete, 24.

Hornby, H. E. (1928). *J. Comp. Path. & Ther.*, **41**, 17.

Kakisaki, C. (1918). *Kitasato Arch. Exp. Med.*, 139.

Mackenzie, R. D., Findlay, G. M., and Stern, R. O. (1936). *Brit. J. Exp. Path.*, **17**, 352.

FOOT-AND-MOUTH DISEASE: A PREFATORY NOTE

As a preface to the two short articles on original research specially contributed to this number by the whole-time workers of the present Foot-and-Mouth Disease Research Committee, of which, until 1937, he has been a member since it (the third scientific committee) was appointed by the Ministry of Agriculture and Fisheries in 1924, the following editorial published by Sir John M'Fadyean in this journal in 1892 is reproduced. It depicts the stand which he took early in its pages and has since consistently and vigorously taken in many other ways during his career, and in especial degree in collaboration with the late Sir Stewart Stockman, in support of the current national policy for dealing with the disease. He was the leader of the first small scientific Committee of the Ministry which proceeded in 1912 to investigate the characteristics of the disease in India, the object being at that time to avoid experimentation in this country. "After a period of six months' active work it was considered inadvisable to continue investigation as it was found that the indigenous cattle, sheep, and pigs of the plains of India were in a high degree insusceptible to the disease and were therefore unsuited for experimental work." (See this journal, 1915, **28,** 91-96.) The researches of Löffler and Frosch upon the aetiology of this disease, the first animal disease proved to be caused by a filterable virus, were brought to the notice of British workers in a very full summary in this journal in 1899 (Vol. **12,** 79-95). The second animal disease proved to be due to a virus was, as is well known, South African horse-sickness (in 1900, by Sir John M'Fadyean). The official researches upon another virus disease, namely, swine fever, and the policies adopted for dealing with it have also been largely determined under his guidance.

The Recent Invasion of Foot-and-Mouth Disease.

In an earlier number of this volume (1892, Vol. **5**) we called attention to the magnificent triumph which the Board of Agriculture had achieved in the struggle waged with pleuro-pneumonia, and devoted some space to an analysis of the factors that had contributed to the victory. At that time, it is true, the disease had not been absolutely exterminated, but it had been so far suppressed as to render it certain that, under a continuance of the same policy, we should soon see the last case of it. This anticipation has been realised. During the third quarter of this year [1892], there were only six outbreaks; and, if we except the cases in imported Canadian cattle, no instance of the disease has been reported since the 1st of October.

An equally great—indeed, in some respects a greater—victory has crowned the efforts of the Board to deal with the recent invasion of foot-and-mouth disease. After an absence of 5 years from our shores, that plague, in some as yet unexplained manner, made its appearance in London in the first week of February last, and before the end of the month it had spread to Kent, Surrey, Sussex and Midlothian. During that month there were in all 24 outbreaks, the number of animals attacked being 600.

Notwithstanding the efforts made to cope with it, the disease continued to spread during the month of March. In that month there were 29 fresh outbreaks, distributed over the counties of Middlesex, Sussex, York, Lanark, Westmorland, Renfrew, Chester and Perth, and the number of animals attacked had risen to 1,755. At that time there were probably few so sanguine as to expect that the country could by any reasonable measures be saved from a repetition of the losses caused by this disease during the early years of the last decade. Fortunately, however, the month of April showed that the measures put in force were beginning to get the upper hand, for during that period there were only 20 outbreaks, though the number of animals attacked had risen to 2,423.

During May, the number of outbreaks fell to eight, and the number of animals attacked to 365, and in June there were only six outbreaks and 117 animals attacked. No fresh outbreaks were reported during the month of July, but anxiety was again created by a reappearance of the disease in Midlothian in August. Fortunately, the

measures taken to prevent its spread from the premises in which it existed there were successful, and by the end of August stock-owners could again breathe freely and congratulate themselves that the country was once more free from a disease which had threatened to exact a heavy tax before its disappearance.

The history of the recent outbreak furnishes another proof of the wisdom of vesting the powers to deal with such animal plagues in one central authority, for no one can doubt that had local authorities been left to cope with the invasion their efforts would have been as abortive as they were on the last occasion of the same kind. The credit of the recent victory is due in equal degree to the veterinary officers of the Board of Agriculture, who advised the measures that have proved so successful, and to the President of the Board, who is responsible for the inflexible manner in which these measures were carried out.

It may be said that what has been done once can, in similar circumstances, be done again, and that there is little reason to fear that foot-and-mouth disease will ever again overrun this country as it did between 1877 and 1885. But it must not be forgotten that the policy of the Board of Agriculture in dealing with the recent invasion was vigorously assailed on the very point that in all probability was most essential to success, and that on another occasion the President of the Board might prove less unyielding. We allude to the effort that was made to discredit the action of the Board in declaring large infected areas. Had effect been given to the representations that were made on that point by certain local authorities, there is little room to doubt that the disease would have defied all attempts to hold it in check, just as it has done and is now doing in several continental states. The recent experience has proved that foot-and-mouth disease, notwithstanding its highly infectious nature, can be stamped out even when it has attained a fair start of suppressive measures, but the risk of failure is so obvious as to make it desirable to take every possible precaution to guard against a re-introduction of the disease. Until recently it was generally supposed that there was little or no danger of the disease being brought to this country so long as the importation of live animals was prohibited from countries in which the disease was known to exist, but the circumstances connected with the appearance of the disease in London and Edinburgh in February last, and more recently in Denmark, lend some colour to the suggestion that the before-mentioned precaution is insufficient, and that the contagium of the affection may be indirectly conveyed from one country to another in imported articles such as hay or hides.

The Board of Agriculture has proved itself a true Institute of Preventive Medicine ; it has set an example which other countries would do well to follow, and in its own success it has the best encouragement to enter upon a struggle with some of the remaining animal plagues.

THE DEMONSTRATION OF A CHANGE IN THE ANTIGENIC STRUCTURE OF A BOVINE STRAIN OF FOOT-AND-MOUTH DISEASE VIRUS DURING SERIAL TRANSMISSION IN THE GUINEA-PIG*

By A. Eccles, E. O. Longley and J. K. Thomson,
Foot and Mouth Disease Research Station, Pirbright.

For some years at Pirbright the limitations of the guinea-pig in determining the true antigenic structure of certain strains of foot-and-mouth disease virus which are responsible for natural, or field, outbreaks have been recognised. We now know that when certain virus strains are passaged in guinea-pigs immunological responses are aroused in these subjects that do not correspond with those obtained with the same strains in cattle. Mention of several such strains that had been received from British field outbreaks was made in the Fifth Progress Report of the Foot-and-Mouth Disease Research Committee (Andrews *et al.*, 1937), and several instances were recorded of the same bovine strain giving rise when submitted to two separate examinations in guinea-pigs to two guinea-pig strains which failed to agree in type. In these cases we mentioned that the facts were possibly not beyond dispute, in that the bovine material was not identical in the two examinations and different periods of storage at low temperature might have affected the character of the material; although our experience had never given us any grounds for suspecting that such an occurrence takes place in stored material. It was, however, considered desirable to re-examine a few of these anomalous strains concurrently in cattle and guinea-pigs. One such strain chosen was Virus 147. A brief description is presented here of our previous examinations of this strain in guinea-pigs, with a more detailed description of our present examination in cattle and guinea-pigs.

Virus 147.

Previous Examination.

This strain was received from a field outbreak in Derbyshire in 1933, and was then established in guinea-pigs. Tests made for type determination at the 14th passage in these animals gave results indicating that the strain was linked antigenically in an atypical form to C type; but no antigenic affinity with O or A types could be demonstrated. A further test was made at the 15th passage, which gave results showing the strain to be definitely C in type. A second examination was made later, starting again from the original bovine virus, but after it had been stored in glycerine buffer phosphate (pH 7·6), at 0° C. for 154 days since some material had been taken

*This work was done on behalf of the Foot-and-Mouth Disease Research Committee, who have kindly given their permission for its publication.

for the first examination. Tests made in this second examination, at the 12th passage, for immunological type gave results which definitely allocated the strain to the O type. That is, two separate examinations of the same bovine virus in the guinea-pig gave it, on the first examination, a C type and, on the second, an O type classification. The only differences between the two examinations were in (1) the number of the passage in guinea-pigs at which examination was made and (2) the length of storage of the original bovine virus. The latter we have no reason to hold under suspicion, as will be evident from our further examination.

Present Examination.

The original bovine virus was taken once more after it had been stored in glycerine buffer phosphate (pH 7·6) at 0° C. for 2 years. Before concurrent tests were made with it on cattle and guinea-pigs, it was put through 2 passages in cattle. A suspension of bovine vesicular lingual epithelium then collected from the 2nd passage, was made in buffer phosphate (pH 7·6); this was tested on groups of cattle and guinea-pigs immune, respectively, to O, A and C types and combinations of these types, namely, OA, OC, AC and OAC. The virus was inoculated into cattle by the intramuscular route, into the flank, and, into guinea-pigs, by the intradermal route, into the plantar pads. The results of these tests are shown in Table I.

TABLE I.

TEST OF VIRUS 147 (*ex* 2ND BOVINE PASSAGE) ON CATTLE AND GUINEA-PIGS.

(*a*) *Cattle.*				(*b*) *Guinea-pigs.**		
Number Tested.	*Animal Nos.*	*Type Immunes.*	*Result.*	*Number Tested.*	*Type Immunes.*	*Result.*
2	N32 N35	O	Both negative	6	O	6 —
2	N64 N65	A	„	6	A	1 + Gen. 5 —
2	O18 O19	C	*Both positive.*	6	C	5 + Gen. 1 —
2	N39 N40	OA	Both negative.	6	OA	6 —
2	N17 N61	OC	„	6	OC	6 —
2	N93 N94	AC	„	6	AC	5 + Gen. 1 —
2	N24 N38	OAC	„	6	OAC	6 —
2	O64 O65	Normal (controls)	*Both positive.*	6	Normal (controls)	5 + Gen. 1 +

*In guinea-pig tests :—
— = no reaction.
\+ = primary reaction only.
\+ Gen. = primary reaction with following generalisation.
Gen. = generalisation without visible primary reaction.

The results obtained from the tests on cattle (Table I,*a*) indicated that this strain, Virus 147, was related to both O and A types, but it would appear from the negative response of the AC and OC immune cattle that the strain did not behave like a mixture of these two types. Further, no relationship with C type could be clearly seen, for animals immune to C type were fully susceptible to infection with it, and in a subsequent test (not tabulated) cattle immune to this virus were found to be fully susceptible to infection with virus of C type.

In guinea-pigs (Table I,*b*) the results also showed that this strain was related to both O and A types. No clear indication of an affinity to C type was apparent.

Normal guinea-pigs were infected with Virus 147 at the same time as the experiment shown in Table I was made, and those reacting with generalised infection were allowed to recover. When recovery was complete, they were divided into 3 groups, which were tested, respectively, with our stock O, A and C type strains. The results are shown in Table II.

TABLE II.

VIRUS TYPES TESTED ON GUINEA-PIGS.

(*a*) *Virus* 147 (*1st passage*) *Immunes.*			(*b*) *Normal* (*Controls*).
Number Tested.	*Virus Type Inoculated.*	*Result.*	
6	O	6 +	All positive.
6	A	6 + Gen.	,,
6	C	6 + Gen.	,,

From the above results infection with Virus 147 gave rise to an O type immunity, and that of a rather weak order, as is shown by the development of primary reactions in all 6 guinea-pigs tested.

Tests upon guinea-pigs that had acquired an immunity against Virus 147 at 1st passage from its bovine source, with the mixed types, OA, OC, AC and OAC were not possible owing to intercurrent disease taking place among them during recovery. The guinea-pigs used for the tests shown in Table II remained available, however, for test with heterologous types. That is: (i) Virus 147 immune guinea-pigs that had been tested originally with O type were later tested successively with A and C types; (ii) Virus 147 immune guinea-pigs, that had been tested originally with A type were later successively tested with O and C types, and, (iii) Virus 147 immune guinea-pigs that had been tested originally with C type were later successively tested with O and A types. In these serial tests, types A and C in all cases produced generalised disease in the guinea-pigs, irrespective of the test order. In tests with type O, out of 10 guinea-pigs tested, 6 gave primary reactions only, while 4 remained negative.

The results of these serial tests were therefore not in disagreement with those shown in Table II. The relationship that had already been shown to exist between Virus 147 and both O and A types (Table I) was emphasised in that the strain was found to be capable of evoking an immunity—a somewhat weak one—only against O type.

The Effects of Serial Transmission of Virus 147 *in Guinea-Pigs.*

The bovine virus was passaged from pad epithelium collected from the 1st passage in guinea-pigs. After 9 passages the strain was again tested on type-immune guinea-pigs. Normal guinea-pigs were also infected to provide immune subjects for reverse tests. The results are shown below, in Tables III and IV.

Table III

Test of Virus 147 (*ex* 9th Guinea-pig Passage) on Guinea-pigs.

Number Tested.	*Type Immunes.*	*Result.*
6	O	6 —
6	A	5 + Gen. 1 +
6	C	6 + Gen.
6	OA	6 —
6	OC	6 —
6	AC	6 + Gen.
6	OAC	6 —
6	Normal (controls)	6 + Gen.

Table IV.

Virus Types Tested on Guinea-pigs.

(*a*) *Virus* 147 (10*th Guinea-pig Passage*) *Immunes.*			(*b*) *Normal* (*controls*).
Number Tested.	*Virus Type Inoculated.*	*Result.*	
6	O	6 —	All positive.
6	A	6 + Gen.	,,
6	C	6 + Gen.	,,

After 10 passages in the guinea-pig, the strain appeared to be definitely of O type. No indication of A type was shown, as had been evident at the 1st passage. The weak O type antigenic response observed at the 1st passage had been considerably strengthened: no primary lesions appeared in the Virus 147 immune guinea-pigs tested with O type.

Tests on guinea-pigs immune towards the 10th passage virus were not made with mixed types. The animals shown in Table IV were subjected to successive tests, however, with heterologous types in the

same manner as the Virus 147 immune guinea-pigs of the 1st passage. In all animals generalised reactions resulted from tests with A and C types, but those tested with O type resisted infection completely.

Passage was continued, and material collected at the 13th passage was subjected to the tests already indicated, with results as below (Tables V and VI).

Table V.

Test of Virus 147 (*ex* 13th Guinea-pig Passage) on Guinea-pigs.

Number Tested.	*Type Immunes.*	*Result.*
6	O	6 + Gen.
6	A	4 + Gen. 2 Gen.
6	C	6 —
6	OA	6 + Gen.
6	OC	6 —
6	AC	6 —
6	OAC	6 —
6	Normal (controls)	6 + Gen.

Table VI.

Virus Types Tested on Guinea-pigs.

(*a*) *Virus* 147 (14*th Guinea-pig Passage*) *Immunes.*			(*b*) *Normal* (*controls*).
Number Tested.	*Virus Type Inoculated.*	*Result.*	
7	O	6 + Gen. 1 +	All positive.
8	A	8 + Gen.	„
8	C	5 + 3 —	„

After 14 passages in the guinea-pig the strain showed a definite relationship with C type. The immunity produced by it was of a weak C type order. No affinity with O and A types such as had been apparent at the 1st guinea-pig passage was shown, or of the pure O type character which was alone evident at the 10th passage. At this stage again, tests on guinea-pigs immune towards the 14th passage virus were not made with mixed types; but the animals shown in Table VI were tested after recovery, successively with the heterologous types. In all these animals generalised disease resulted from types O and A, while of 11 tested with type C, all remained negative.

At the 14th passage, the virus was again tested in the foregoing manner, with results as shown below (Tables VII and VIII).

TABLE VII.

TEST OF VIRUS 147 (*ex* 14TH GUINEA-PIG PASSAGE) ON GUINEA-PIGS.

Number Tested.	*Type Immunes.*	*Result.*
6	O	5 + Gen. 1 —
6	A	6 + Gen.
6	C	6 —
6	OA	6 + Gen.
6	OC	6 —
6	AC	2 + 4 —
6	OAC	1 + Gen. 5 —
6	Normal (controls)	6 + Gen.

TABLE VIII.

VIRUS TYPES TESTED ON GUINEA-PIGS.

(*a*) *Virus* 147 (*15th Guinea-pig Passage*) *Immunes.*			(*b*) *Normal* (*controls*)
Number Tested.	*Virus Type Inoculated.*	*Result.*	
6	O	6 + Gen.	All positive.
7	A	6 + Gen. 1 +	,,
7	C	3 — 4 +	,,

The behaviour of the virus at the 14th passage was similar to that at the 13th passage, showing the strain was of the C type.

The change in type of this strain from OA at the 1st to pure O at the 10th, and to C at the 14th passage was not altogether unexpected in view of the results obtained at previous examination. It was, however, considered desirable to confirm these findings in the present series of experiments. A repeat test (Table IX) on guinea-pigs immune to O, A and C types was made with part of the stored suspension of 13th passage material, which had been used in preceding test (Table V). No tests could be made on mixed type immunes as, owing to guinea-pig shortage, none was available.

TABLE IX.

REPEAT TEST OF VIRUS 147 (*ex* 13TH GUINEA-PIG PASSAGE) ON GUINEA-PIGS.

Number Tested.	*Type Immunes.*	*Result.*
6	O	6 + Gen.
6	A	6 + Gen.
6	C	1 + 5 —
6	Normal (controls)	6 + Gen.

This repeat test confirmed the C type result obtained in the former test with the 13th passage material.

An attempt was also made to ascertain if any type difference could be demonstrated between the blood virus and pad virus of the 13th passage. The guinea-pigs which had provided virus at the 13th passage had been bled when pad material was collected. The serum obtained was tested in the usual way on type immune guinea-pigs, and the results (Table X) obtained showed the blood virus to be also of C type.

TABLE X.

TEST OF VIRUS 147 (VIRULENT SERUM *ex* 13TH GUINEA-PIG PASSAGE) ON GUINEA-PIGS.

Number Tested.	*Type Immunes.*	*Result.*
6	O	6 + Gen.
6	A	6 + Gen.
6	C	6 —
5	OA	5 + Gen.
6	OC	6 —
6	AC	6 —
6	OAC	6 —
6	Normal (controls)	5 + Gen. 1 —

Stored material, in the form of pad epithelium, that had been collected from all the intervening passages between the 9th and the 13th passage was now tested. This material, of the 10th, 11th and 12th passages, was tested on guinea-pigs immune to O, A, and C types, adequate controls being used for each (Table XI). No reverse tests were made, as no guinea-pigs were available to furnish immune groups.

TABLE XI.

TEST OF VIRUS 147 (*ex* 10TH, 11TH AND 12TH GUINEA-PIG PASSAGES) ON GUINEA-PIGS.

Inoculum ex Passage.	*Number Tested.*	*Type Immunes.*	*Result.*
10th	6	O	6 —
	6	A	4 + Gen. 2 Gen.
	6	C	5 + Gen. 1 —
11th	6	O	1 + Gen. 2 Gen. 3 —
	6	A	4 + Gen. 2 —
	6	C	2 + Gen. 4 —
12th	6	O	6 + Gen.
	6	A	6 + Gen.
	6	C	1 + Gen. 1 + 4 —

The 10th passage material disclosed virus of O type; 11th passage material showed evidence of C, O, and A types, in this order; while 12th passage material showed no evidence of O or A types, but stronger evidence of C type. It would appear, therefore, from this series of tests that type transition was occurring in this strain during the 12th passage in guinea-pigs.

The results hitherto reported have all been concerned with the immunity response of this virus strain as compared with the responses produced by the standard O, A, and C types and various combinations of these types. The immunity produced in guinea-pigs by these types was tested against infection by the strain, or the immunity produced by the strain was tested against infection by O, A, and C types alone or in combination. Two tests were made, however, to ascertain whether the types analysed during passage in guinea-pigs could be identified in the parent virus (Table XII). Immune guinea-pigs that had recovered from infection at the 1st passage, were tested with material collected at the 9th (= O type) and at the 13th (= C type) passages.

TABLE XII.

TEST OF FIRST PASSAGE VIRUS 147 IMMUNE GUINEA-PIGS WITH 9TH AND 13TH GUINEA-PIG PASSAGE VIRUS 147 MATERIALS.

Inoculum ex Passage.	*Number Tested.*	*Result.*
9th	6	6 —
13th	6	6 + Gen.

Tests in the reverse direction and further comparison by testing with 13th passage virus of the immunity resulting from infection with 9th passage material and *vice versa*, would have been desirable but facilities for these tests were not available. The tests so far made, however (Table XII), show quite clearly that while the immunity produced by the parent bovine virus at its 1st passage in guinea-pigs was capable of protecting against infection with the closely homologous type identified at the 10th passage, it was incapable of protecting against infection with the heterologous type identified at the 13th passage.

SUMMARY AND CONCLUSIONS.

A strain of foot-and-mouth disease virus from a natural bovine source has been examined for type identity concurrently in cattle and guinea-pigs. In cattle a relationship with both O and A types was demonstrated, but no apparent relationship with C type. At the 1st passage of this strain in guinea-pigs classification of type was almost similar. After the strain had undergone 10 passages in guinea-pigs,

definite classification as O type was possible, with no evidence of the original A type factor. After 14 passages it was classifiable as C type. The intervening 12th passage gave indication of the apparent presence of C, O, and A type antigens.

The parent bovine virus, at its 1st passage in guinea-pigs, was incapable of producing an immunity which would protect these animals against reinfection with a type demonstrable in virulent material after serial guinea-pig transmission. The results obtained in two previous separate examinations of this strain in guinea-pigs have been confirmed in so far as it has been possible during this subsequent examination to demonstrate in the strain the two types that had then been identified.

Storage in glycerine buffer phosphate (pH 7·6) at 0° C. over a period of 2 years, does not appear to have resulted in any change of type in this strain.

It is not proposed in this note to speculate upon the type constitution of the foot-and-mouth disease virus, or to review the literature on the subject. The work reported is still incomplete, but provisional interpretation confirms our previous findings (*a*) that certain naturally occurring strains of foot-and-mouth disease virus are of much more complex immunological structure than was formerly supposed, and (*b*) that the guinea-pig appears to be capable of dissociating the antigenic structure of these strains and of producing mutations in them at various stages of serial transmission. Some of these guinea-pig antigens can be demonstrated in the parent strain when it is examined in cattle ; others cannot be clearly identified. The true significance of these immunological factors can only be estimated when the results of further comparative observations are available on the behaviour of these strains in guinea-pigs and in their naturally susceptible hosts.

FOOT-AND-MOUTH DISEASE IN HIBERNATING HEDGEHOGS

By E. C. Hulse and J. T. Edwards,
Foot-and-Mouth Disease Research Station, Pirbright.

Section I.—Hibernation.

Foot-and-mouth disease attacks hedgehogs more severely than any other species known to be susceptible (Edwards, 1931), and infection may be seen to spread rapidly among them. Whereas the other small animals used in the laboratory can only be infected by inoculation, the hedgehog is the only one that can be used to study the disease in the form in which it occurs in the larger susceptible animals, namely, as a naturally transmissible infection.

One of our findings (unpublished) has been that the respiratory tract is affected in the severe transmissible disease in the hedgehog. Lesions are found in the nasal mucosa and lungs similar to those seen in animals infected experimentally with the influenza virus. The diseased animal transmits infection while virus is found to be exhaled in its breath. Whether the common method of transmission is by the respiratory route has not, however, been conclusively proved.

In carrying out work with hedgehogs we have come across several difficulties which are outside the common experience in working with other animals and render the solution of an apparently simple set problem often one of unexpected complications. Stocks are obtained from a firm of dealers who have had them caught wild from various parts of the country. They are kept at once separately, on account of their proneness to attack each each other when first brought into captivity, and fed on a special mixed diet to coax them to eat (Edwards, 1937). For several weeks they may refuse to eat and many die, so that great care is needed in noting the progress in condition of each animal before it is brought on experiment. As with other species, those in bad health and poor condition, and falling in weight resist infection with the virus of foot-and-mouth disease. The animals being nocturnal in their habits are caught at night, and feeding takes place in the evening. After some time in captivity, however, they are found to be quite active in the daytime.

Another difficulty in working with hedgehogs relates to the great care that must be taken in maintaining the environment in a favourable state, more especially as regards the temperature. Stocks for research become available seasonally. They are plentiful in the country from May to October. Many of those caught in the early part of this period are pregnant females—which again give rather irregular results in experiments. At the end of this period, when the weather is getting colder, many harbour catarrhal infection, with the presence of *Brucella bronchiseptica* in the respiratory tract, which spreads and

becomes highly virulent if the animals are not kept separate. Then, during the colder months of the year, hedgehogs in the wild fall into a state of winter sleep or hibernation. It is some observations we have made in the course of our work upon hedgehogs in this state that we wish to record in this paper.

In preceding experiments (unpublished) it had been found that hedgehogs in a state of hibernation became completely resistant to foot-and-mouth disease infection. The observations we have to record suggest, however, that this state of the animal may play rather an important part in the natural history of the disease.

Some Remarks on Hibernation.

There are several species of birds and mammals that live in the temperate and cold regions of the earth where their particular food, which may be green plants, certain fruits, or insects, becomes plentiful and sufficient to maintain their bodily activities only during a limited season of the year. During the rest of the year the food supply is insufficient for their requirements. The birds migrate to distant lands where they can still find food. The mammals suspend their bodily activities to such a degree that their energy requirements are reduced to a minimum. Their heat-regulating mechanism is thrown out of action so that, as with cold-blooded animals, the temperature of their bodies is that of the environment. They do not eat or drink; the muscles are stiff; hedgehogs become hard to uncurl, and they cannot be awakened from their sleep by any of the ordinary stimuli. Some species are said to wake up periodically to urinate (Fleischmann, 1931); we have not seen this to occur in the hedgehog. During this period the animal is able to live without drinking, it is said, because it depends for its energy solely on its stores of body fat and the water remaining after fat combustion suffices for the body's needs. If it is supplied with hay for litter, the hedgehog prepares carefully for hibernation by rolling the hay tightly round itself in the form of a thick cocoon. Hibernating animals awaken or die when they are exposed to excessively low temperatures.

During hibernation the accumulated stores of body fat disappear so that a hedgehog weighing about 800 grammes may lose 200 or 300 grammes in weight. The heart beats and pulse rate are slowed down to a quarter of the normal rate; some observers have reported a pulse rate of 4 or 5 per minute (Johnson, 1931). The respiration is also slowed down, from 25 to 40 down to 4 to 5 per minute, and it is so shallow that the animals do not appear to be breathing at all. The rectal temperature falls from 95 to 98° F., a figure which is very uniform in the active hedgehog, down to 40 to 45° F. and the body feels "stone-cold." The hedgehog does not react by showing a rise in temperature in foot-and-mouth disease. We have never noted a distinct febrile response in the hedgehog, an experience very different from that obtained with ferrets infected with the influenza virus, for example. Whether it is due to some inability of the heat-regulating mechanism to respond as compared with the extreme sensitivity of this mechanism in the ferret, we do not know. Nevertheless, in our routine experimental work, care is taken to note daily the rectal temperatures of hedgehogs, for the reason that a drop would indicate commencing hibernation with consequent failure to respond normally to foot-and-mouth disease infection.

Hibernation in mammals has been the subject of several interesting

observations by natural history workers and physiologists in recent years. It is regarded by some as an evolutionary adaptation. It is, however, found in primitive types, such as the Australian ant-eater and the duckbill. It is again found in several families higher in the scale, such as the Insectivora (which includes the hedgehog), the bat family, several rodents, such as the ground squirrel, the many species of dormice and the marmot. On the other hand, several workers look upon the phenomenon as one suggesting imperfect development of the heat-regulating mechanism, which can soon be thrown out of action when there are excessive demands placed upon it. Eisentraut's recent observations (1934) on bats are of interest in this connection. He found that during daily sleep in summer their body temperature sinks to that of the environment and they fall asleep; yet they awaken at night. During their daily sleep, the body functions are slowed down, but they can be aroused from sleep by touching or other stimuli. The bat awakens when its temperature rises above 35° C. Daily sleep changes to winter sleep when the outside temperature drops to about 10° C. Winter sleep is much deeper than daily sleep; the body temperature may drop below 0° C., when the life of the animal may be endangered; a temperature of –5° C is fatal. The animal may enter into varying depths of hibernation according to the temperature: (1) experimental, below 0° C. with rigidity and presence of spinal cord reflexes only; (2) deep hibernation, over 0° C. with presence of clinging reflex; (3) light hibernation, about 10° C. when there is evidence of cerebral activity; (4) transition stage to awakening.

Does change in temperature account for hibernation? Although the normal period for hibernation in the hedgehog is during the winter, from the end of October to the end of February, March or beginning of April, depending on the locality, we have found that hedgehogs in captivity may commence to hibernate at any time of the year if they are subjected to sudden chilling. This may take place in a disconcerting way in the course of experiments when their cages are placed near a damp floor or exposed to draughts from a window or doorway. Care has to be taken, therefore, to maintain all experimental animals at a room temperature of about 75° F. Again, when they are maintained at this temperature, hedgehogs have been easily induced to remain active throughout the year.

At times of the year other than the normal hibernating season, it has not been found easy to induce hedgehogs regularly to drop into a state of hibernation and remain in it uninterruptedly. For example, in the month of July last, out of 136 hedgehogs removed into a cold room (temperature 39 to 42° F.) for 24 hours, only 27 (about 20 per cent.) were found to have hibernated; 24 of these were returned to the ordinary temperature of the animal house, where they awakened. After a few days these animals were infected with virus, and returned to the cold room; only one hedgehog hibernated after this second exposure to cold.

Again, with hedgehogs kept at low temperatures in an attempt to cause them to hibernate, during the cooler months of the year, it is found that individual animals vary a good deal; some are easily roused with slight fluctuations in the outside temperature, others persist steadily in hibernation. During the latter part of last winter, when there were frequent mild spells, we failed in some of our experiments to maintain most of our infected hedgehogs in a state of hibernation, by keeping them in containers exposed to the unregulated temperature of the environment. For further work, we proceeded to maintain our stocks in a thermostatically controlled room. Under natural conditions, it is obvious that a hedgehog would be free to

roam until it found a place, in hedgerows or undergrowth, where the temperature was least likely to fluctuate violently during the winter.

These observations are paralleled by those of other workers on the hibernating species. It is clear that the degree of temperature of the environment does not wholly account for the phenomenon. Chilling or warming may induce an animal to drop into or awake from a state of hibernation, but the maintenance of this state seems to depend upon a cyclical seasonal change in the internal properties of the animal. An interesting point is that in tropical countries some mammals, such as the small insectivorous animal, rather like a hedgehog, called the tanrec, in Madagascar, drop into a state akin to hibernation (æstivation) during the hot, dry season of the year. Shortage of food, again, will not induce the animals to hibernate (Fleischmann, 1931).

The Cyclical Variations in Endocrine Activity in Hibernating Animals.

Light was first thrown on the mechanism of hibernation by the fundamental discoveries of the pharmacologist Adler, of Frankfort, in 1920 (Fleischmann, 1931). Working with hedgehogs and bats, he found that a very marked difference was seen between the histological picture of the thyroid gland in the hibernating and in the active animal. In hibernating animals the thyroid showed marked atrophic changes, and awakening was ushered in by the gradual restoration of the gland to the state in which it is seen in the normal warm-blooded animal. Again, when deeply hibernating hedgehogs, kept at a low outside temperature (5° C.) were injected with thyroid or adrenal medulla extracts they quickly awoke ; pancreatic extract had no effect.

These findings, so far as the thyroid changes are concerned, have been confirmed upon marmots by another worker, Coninx-Girardet (Fleischmann, 1931), who also found marked seasonal changes in the pituitary. On the other hand, as has been found by the Toronto workers, Dworkin and Finney (1927), virgin marmots kept at warm summer temperature and simultaneously chilled and injected with large doses of insulin fell into hibernation. The same has been found by other workers to apply to squirrels (Fleischmann, Dische and Trewani, 1929).

These reactions would demonstrate the antagonism that exists between the action of thyroid and adrenalin on the one hand and insulin on the other hand. The hormone action would seem to be exercised by its effects on the vegetative nervous system, adrenalin having a stimulating effect on the sympathetic. According to Bruman (1929) atropine, which has an inhibitory effect on the parasympathetic, has been found on injection to cause dormice to awake from hibernation (Fleischmann, 1931).

Some interesting studies have been reported recently upon the influence of cyclical variations in hormone activity upon reproduction in the hedgehog. In the male, the seminal tract is in a state of complete rest from October to January : the whole tract becomes atrophied and spermatogenesis is arrested. This recommences in spring, and there is a gradual hypertrophy of the whole genital tract, with great development of the seminal vesicles, internal and external prostates and testicles. The rutting season corresponds with the two breeding periods of the female, in May and August. It has been found (Herlant, 1932) that this development in the male can only take place through the intermediary of the interstitial cells, the so-called " interstitial gland " of the testicle ; this interstitial gland is considerably hypertrophied during the rutting period.

There is, therefore, a very marked ebb and flow in the endocrine activities of the body corresponding with winter and summer which would explain the normal alternation of hibernation and wakefulness.

Other Observations on the Tissues of Hibernating Animals.

Excised tissues, for example the liver, do not show any change in their properties *in vitro*. Histologically, many types of cells do not appear to stain so well (Carlier, 1893).

The metabolism is greatly decreased; it has been found to drop as low as 5 or even 1 per cent. The respiratory quotient is very low, down to 0·25. When the animal is awake it is up to 1. Shortly after awakening from hibernation it is still higher, 2·2 to 3·4 (Dontcheff and Kayser, 1935). A good deal of work has been done by physiologists, including the late Professor Pembrey, from 1902 onwards, to find out the cause of this change. It seems to be explained mainly by the greater solubility of gases in the blood at low temperatures; the carbon dioxide being more soluble than oxygen it would be retained in higher concentration, and on warming after awakening it would be expelled in greater amount; the respiratory centre also would be restored to its normal sensitivity to carbon dioxide. The carbon dioxide tension in the blood only rises slightly in hibernation.

There has been much discussion as to whether the fat on which the body subsists is converted into carbohydrate during hibernation. Against this view, the experiments of Weinland (1925) have shown no increase in glycogen in the tissues. The matter does not appear to be solved.

The blood sugar is lowered but does not sink below 50 mg. per cent., so that there is no decided hypoglycæmia.

Urine is present in the bladder in only a very small quantity in the hedgehog: it is said to contain an excess of amino-acids at the expense of the urea fraction.

The stomach and intestines of the hibernating hedgehog are empty. The stomach lining is covered with a protective layer of mucus. The white blood corpuscles may drop from 20,000 to 1,000 per c.mm.; the red corpuscles may increase. In the liver there are masses of pigment granules in the cellular network between the liver cells, which have probably accumulated through sluggish excretion (Carlier, 1893). The spleen shows a remarkable increase in lymphoid tissue, with fatty tissue distributed among the lymphoid tissue (Hoepke, 1931). The lymphatic glands seem to be in a resting state; few mitotic figures are seen; the number of phagocytes is greatly increased; the large mononuclears contain pigmented granules, possibly ingested decomposing red blood corpuscles. Many brownish granules are found free in the lymph. According to Carlier, the lymph stream acts as a purifier of the tissues during hibernation.

Formerly what was regarded as a "hibernating gland" was supposed to have some connection with hibernation. This is now known not to be a gland but merely a fat depot. In the hedgehog, it is a bilateral, lobulated, orange brown mass of fat in the axillary, cervical and dorsal regions. The coloration is due to the high lipochrome content. It is largest at the end of October, when it may attain over 3 per cent. of the body weight and it decreases to below 1 per cent. at the end of March. Its fat differs in distribution from ordinary fat. The fat is present in the cells in the form of numerous small droplets; much cytoplasm remains, running through the fat like septa. The nuclei remain rounded or polygonal and are not

flattened ; there is a very rich blood supply. The so-called gland is really a large reservoir of readily convertible fat.

Some interesting observations have been made upon the state of the nervous system during hibernation. It is an old popular observation that the trunks of sleeping bats that have had their heads chopped off, will flap their wings and fly away from the head when they are warmed up.

Section II.—The Influence of Hibernation on the Course of Foot-and-Mouth Disease Infection in the Hedgehog.

A.—Long Survival of Virus in the Bodies of Hedgehogs infected shortly before they drop into Hibernation.

It has already been said that no multiplication of the virus was found to take place in the bodies of hibernating hedgehogs. It remained next to be seen whether the virus could persist in the bodies of hedgehogs that had become infected in the active state and then dropped into hibernation while in the incubation stage of infection : that is, before lesions were seen on the feet and tongue. In a first experiment (A), begun in the middle of December, 1936, a group of 12 hedgehogs was infected by the intranasal route. To retard spread of infection to other tissues beyond the respiratory tract, these hedgehogs were each inoculated at the same time with a dose of antiserum. It had already been shown by us that by this means (unpublished results), multiplication of the virus could be confined to the respiratory tract, where the virus might be detected up to about 10 days in the active animal. After 48 hours the bins in which the hedgehogs were kept were transferred to the floor of a dark room which was covered to the depth of about 3 in. with running tap water. The plan was to kill off the animals in groups of three at monthly intervals and examine their tissues for distribution and concentration of the virus. The temperature of the room fluctuated daily rather considerably from 30° to 60° F. during the first month. Unfortunately it was found impossible to continue the experiment satisfactorily after the second month, on account of the mildness of the weather, which caused the hedgehogs to wake up. However, in the group killed after 28 days, virus was found (as shown in the Chart) in high concentration in the internal tissues of all three hedgehogs examined. In two (750, 751) which had remained continuously in hibernation from the 6th day onwards, it was present in nearly 1 : 100,000 concentration in the lungs ; in the third (758) which had awakened for 2 days and then relapsed, it was found in much lower concentration. Further, it had migrated elsewhere in hedgehogs 750 and 751, being found in the nasal mucosa of 750 and in the heart-blood, liver and spleen of both. No lesions were seen on the tongue and feet, and no virus was found in these tissues (the very small amount found in the tongue of hedgehog 750 being due probably to the blood contained in the excised underlying tissue). In the second group killed at 2 months, one which had remained continuously in hibernation, namely hedgehog 754, showed severe lung lesions, and virus was recovered

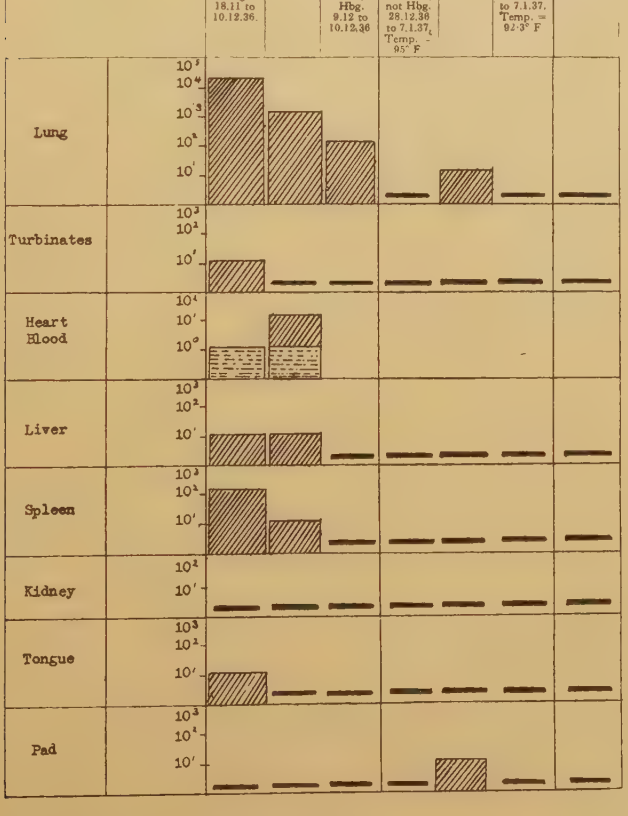
CONCENTRATIONS OF F. AND M. VIRUS IN TISSUES OF HIBERNATING HEDGEHOGS INFECTED BEFORE THE ONSET OF HIBERNATION.

A (750-761): each inoculated intranasally with virus (1·0 c.c. 1/25 g.p. lymph, strain V. 185) and intramuscularly with serum (2·0 c.c. anti-V. 185 g.p. convalescent) on 12.11.36; transferred after 48 hours to dark room maintained at low outside winter temperature with running tap water.

B (837-842): each inoculated intranasally with virus as above (no serum) on 26.1.37, and placed after 30 hours in a thermostatically controlled cold room; only one, 839, remained continuously in hibernation, for 4 months, and was examined.

[Concentrations of virus were determined in the usual way, by I.D. inoculation of guinea-pigs with falling dilutions (wt./vol.) of tissues.]

Interval after Infection	*A. 4 Weeks*			*A. 8 Weeks*			*B. 4 Months*
Hedgehog No.	750	751	758	753	754	755	839
External F. & M. Lesions	0	0	0	0	0	0	Healed feet lesions
Lung Lesions	++	+	+	Healed lesions	++	Healed lesions	Doubtful lesions
Bacteria, Lung	0	0	++*	0	0	0	0
„ Turbinates	++	+	+	+	++	++	0
Hibernation, Remarks	Hbg. 16.11, not Hbg 17.11; Hbg. 18.11 to 10.12.36.	Hbg. 18.11 to 10.12.36	Hbg. 19.11 to 6.12; not Hbg. 7.12; Hbg. 9.12 to 10.12.36	Hbg. 16.11; not Hbg. 17.11; Hbg. 18.11 to 28.12, not Hbg. 28.12.36 to 7.1.37, Temp. = 95° F	Hbg. 16.11.36 to 7.1.37, Temp. = 52° F	Hbg. 16.11 to 28.12; not Hbg. 28.12.36 to 7.1.37, Temp. = 92·3° F	Hbg. 27.1 to 25.5.37.



* *Brucella bronchiseptica* (in lung of 758). No virus was detectable in heart bloods except where indicated (*i.e.*, in 750 and 751).

from the lungs and feet. The other two, which had been awake for a fortnight before their tissues were examined, disclosed no virus.

The result shows that virus can be found in the internal tissues of hedgehogs for 2 months when they drop into hibernation shortly after infection. In another experiment (B) carried out later, out of 6 hedgehogs which were infected intranasally and placed in a thermostatically controlled cold room, only one (839) remained in hibernation throughout the 4 months' period of the experiment, and no virus was detected then in its tissues, but there were signs of healing lesions on its feet.

It is probable that the virus will be found to persist for a much longer time than has been determined in these experiments when we have succeeded in inducing hedgehogs to remain in deep hibernation for long periods as in natural conditions.

B.—Development of the Clinical Disease in the Hedgehog after it has Awakened from Hibernation and Spread of Infection to healthy Hedgehogs.

One of the hedgehogs (752) in the group (A) that has been referred to above, was removed to the ordinary experimental room, temperature about 75° F., 32 days after infection ; it then showed no external lesions. It revived quickly and was warm and active within 4 hours. It was then placed in a larger bin in contact with two healthy hedgehogs. Three days later, the awakened hedgehog showed well marked foot-and-mouth disease lesions ; the disease ran a rather mild course and the animal recovered. Both contact hedgehogs developed clinical foot-and-mouth disease, one showing marked lesions ; both recovered from the infection. The results show that hedgehogs infected just before hibernation may harbour the virus in their bodies for a long time, develop clinical foot-and-mouth disease on awakening, and spread infection.

Discussion.

Similar experiences have been recorded by other workers. H. H. Meyer and Halsey (Fleischmann, 1931) found hibernating bats to be resistant to tetanus. After inoculation and keeping them for several months in the cold, they developed tetanus on awakening. Hibernating animals also show great resistance to chronic poisoning. Hausmann (Fleischmann, 1931) found that bats when fully awake could be killed after an incubation period of 2 days with a dose of colchicine that was less than 1/30th the dose found insufficient to kill hibernating bats. Further, when hibernating bats were injected with this poison and then kept in the cold they developed symptoms of poisoning on awakening after an interval, as if they had been poisoned at the moment of awakening.

C.—Mildness of Attack in Chilled Hedgehogs.

It has already been said that besides the typical severe fatal disease, milder attacks, terminating in recovery, are commonly seen in hedgehogs. Occult forms of disease are also seen where, for example, after contact infection, the fact that the hedgehog has passed through an attack is detected only by its resisting a subsequent inoculation test. These milder forms are seen especially in poor animals and in those inoculated with small doses of virus or with a weak strain of virus. As Roemmele (1930) and others have shown in the case of guinea-pigs, we have found that hedgehogs kept at cool temperatures and not hibernating, develop very mild lesions or an occult disease. This was seen in an experiment we have already referred to, in which in July last a group of 24 hedgehogs, after intranasal infection, was placed in the cold room. They did not hibernate, except in the case of three animals, which awakened after a few days. Only very mild or no lesions were seen. After 43 days, 14 of the survivors were replaced in the ordinary warm animal house, each in contact with a healthy hedgehog; none transmitted the infection. It would seem therefore the non-hibernating hedgehogs, after recovery, were proved not to be spreaders of the disease.

Of the above 14 hedgehogs, 13 were afterwards found to be immune to the same type of virus (O). All were later found susceptible to infection by another type of virus (A).

D.—Finding of Hedgehogs naturally immune to one type of Virus and fully susceptible to other types.

The findings now reported would suggest that provided hedgehogs are in good condition and are kept in the active state in a suitable environment, that is, they are "standard" animals, they ought invariably to show severe disease after inoculation with a good strain of virus. If any should be found to be completely immune, it is possible that this would be as the result of recovery from infection. We have not hitherto carried out any experiments especially to determine to what extent hedgehogs caught in the field may be found immune in this way. Work of this kind, to lead to reliable results, would need the maintenance of large stocks of hedgehogs caught in different parts of the country, so as to be sure that they were in a fit state for the inoculation test, and that they had reached the state of "standard" animals.

However, in the course of other work during the last 4 years, in which we have used about three thousand hedgehogs, in various experiments, we have come across three "standard" animals which seemed to be resistant to one type and highly susceptible to another type.

The first case of this kind was found by one of us (J. T. E.) in 1934. Six hedgehogs in good condition, that after arrival had been kept in strict isolation, were placed in bins, each in contact with two

healthy hedgehogs and inoculated into the skin of the feet with a powerful virus (O type) in the form of fresh lymph taken direct from the feet of an infected animal. Five developed severe disease and transmitted infection to the contact animals. One showed no trace of lesions and the contacts remained healthy. It was reinoculated later with the same type with the same negative result. Afterwards it was inoculated with another type (A) into the feet. It developed severe foot-and-mouth disease, from which it died, and it transmitted severe infection to both hedgehogs in contact with it.

Two suspicious cases of this kind have come under our notice during the present year. The results are therefore too few to warrant any conclusion.

Conclusions.

(1) The results reported would tend to show that the hedgehog is capable of playing an important part as a carrier of foot-and-mouth disease infection.

(2) This animal can harbour a latent form of infection for a long period while it is in a state of hibernation, and can transmit the disease on awakening.

Acknowledgments.

This work was carried out by the authors while employed by the Foot-and-Mouth Disease Research Committee to whom thanks are due for all the facilities provided and for permission, through Dr. W. H. Andrews, to publish.

References.

Carlier. (1893). On the Hedgehog. *J. Anat. & Physiol.*, **27.**

Dontcheff, L., and Kayser, C. (1935). Explications de certains quotients respiratoires aberrants chez les hibernants. *C. R. Biol., Paris,* **118,** 81-85.

Edwards, J. T. (1931). 4th Progress Report, Foot-and-Mouth Disease Research Committee, 164-179.

——. (1937). Discussion on Nutrition and its Effects on Infectious Disease. *Proc. Roy. Soc. Med.*, **30,** 9, 1039-1052.

Eisentraut, M. (1934). Bats. *Z. Morph. Oekol. Tiere*, Berlin, **29,** 321-267.

Fleischmann, W. (1931). Physiologie des Winterschlafes. *Biol. Generalis Wien.* **7,** 620-630.

Herlant, M. (1932). Recherches d'histophysiologie genitale chez le Hérisson hibernant. *Arch. Anat. micr. Paris*, **28,** 335-362.

Hoepke, H. (1931). Die Milz von Igel und Fledermaus in und nachdem Winterschlaf. *Verh. anat. ges. Jena*, **40,** 216-227.

Johnson, G. E. (1931). *Quart. Rev. Biol.*, **6,** 439-461.

Roemmele, O. (1930). Der Einfluss verschiedener Temperaturen auf den Verlauf der experimentellen Maul- und Klauenseuche. *Z. InfektKr.*, **38,** 102.

Wienland, E. (1925). Ueber den Gehalt an einigen Stoffen beim Igel in Winterschlaf. *Bioch. Z. Berlin*, **160,** 66-74.

SOME LABORATORY AIDS

By A. Leslie Sheather, D.Sc., M.R.C.V.S.,
Chorleywood, Herts.

No. 1.—An Electric Switch Operated by Clockwork.

In any work involving the repeated use of an electric centrifuge running for a definite period each time, a considerable loss of time may result if one has to watch the clock and switch off by hand.

This can be obviated by a device whereby the current can be switched off automatically after any predetermined interval (up to an hour). An ordinary clock, costing about five shillings, with its glass removed is placed on a small shelf fixed to the switchboard. So that the clock may remain steady and always be replaced in exactly the same position after winding, two holes are drilled in the shelf to accommodate its short, peg-like legs. Just in front of the clock and below it is a spring-loaded vertical plunger running through a tube which has a narrow slot about $\frac{1}{2}$ in. long in its upper end. A stiff wire " trigger " is fixed in a hole drilled through the upper end of the plunger rod. This trigger projects a short distance through the plunger rod on one side, and on the other it is bent up and then at a right angle like an inverted capital " L." The lower end of the plunger rod has a thicker piece of tubing passed over it, the position of which can be fixed by means of a set-screw. Below the clock shelf, and at a suitable distance is a tumbler switch of the ordinary type, the knob of which has been drilled and a metal rod about 2 in. long soldered into it to increase the leverage. This switch is fixed to the board in the opposite position to the usual one, that is to say, the current passes when the knob is upwards. To set the switch, the minute hand of the clock is first set to the required period of running, counting backwards from the half-hour position. The plunger is then raised and turned slightly to the right so that the short stub-end of the trigger wire rests on the lip of the cleft in the tube. See that the ordinary starting switch, which is of course wired up in the circuit, is turned off. Then turn on the tumbler switch by pushing the lever upwards, and start the machine with the ordinary starter switch. As the minute hand approaches the half-hour position, it comes into contact with the wire trigger, and the pressure causes the plunger rod to rotate until the spring pulls it down smartly as the stub-end of the trigger slips into the slot. This causes the lower end of the plunger rod to give a sharp rap on the rod prolonging the knob of the tumbler switch, and turns it off. The purpose of the piece of metal tubing on the lower end of the plunger rod is to enable the correct adjustment to be made to effect this.

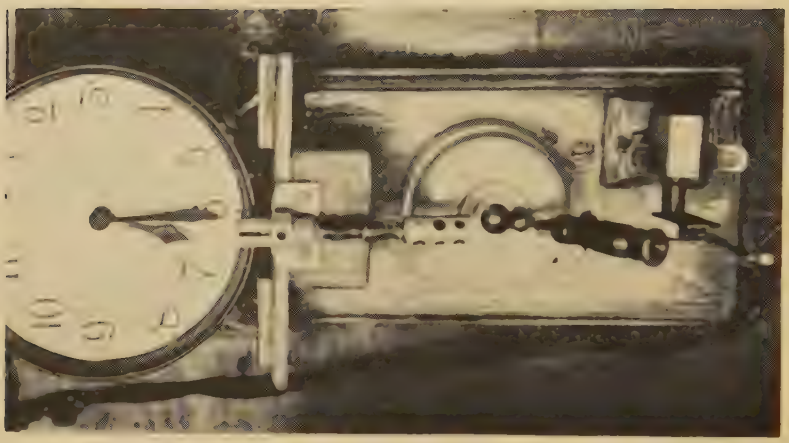


Fig. 2.

Fig. 1.

The photograph (Fig. 1) shows the general arrangement of the starter panel, with the switch in the " on " position. Fig. 2 shows the mechanism in more detail with the switch in the " off " position. In Fig. 1, below the switch is a " counter " which registers every time the tumbler switch is turned on. This was incorporated because some trouble was experienced at one time with uneven and rapid wear of the centrifuge brushes, and it was desired to ascertain their length of life.

A further means of preventing loss of time is to have two sets of buckets, so that one set can be got ready while the others are in the machine.

No. 2—Agglutination Tests.

When large numbers of agglutination tests have to be carried out two problems arise, namely incubator space and the cleaning of large numbers of tubes.

The ordinary racks require a large amount of space in the incubator and the tubes have to be removed, and washed individually.

Racks may be replaced by strips of wood, of such length as can be accommodated by the width of the incubator chamber, about $\frac{5}{8}$ in. wide, and $\frac{1}{8}$ in. thick. These strips are readily made from ordinary builders' laths. The two edges of one of the faces of the wood are rounded off. To these strips the tubes are attached, packed together as closely as possible, by rubber bands. The rounding of the edges of the wood is to reduce the risk of the bands breaking. It is my practice to have the tubes behind the wood, so that serial numbers may be stamped on its face. The rubber bands are placed over the necks of the tubes, down over the front of the wooden strips and then back again round the tubes below the wood. The arrangement is readily seen in the photograph (Fig. 3).

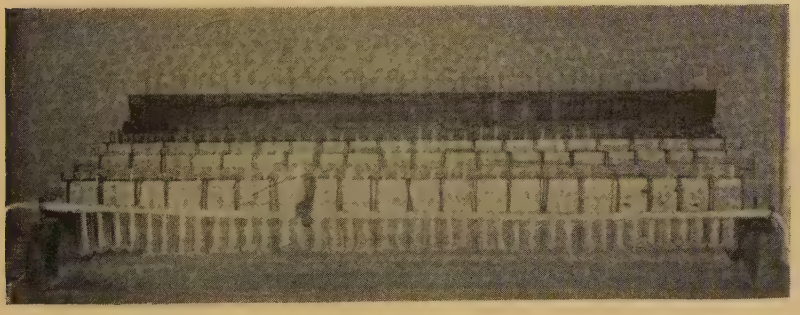


Fig. 3.

For the incubation of a number of such sticks a frame is made as follows. The wood used is about 2 in. by rather less than $\frac{1}{2}$ in., and

is readily obtained in these measurements under the name "door-stop." The sides of the frame, which are on their edges, are connected by two pieces, one at the front and one at the back, on the flat. The dimensions of the frame are governed by the size of the incubator shelf. The upper edges of the side pieces are furnished with rows of pegs (headless nails) in pairs, so spaced that each pair hold the ends of what I may call the tube stick, with sufficient space between the pairs for the tubes themselves. Across the front of the rack is a metal rod carrying a sliding pointer, which is moved along as each set of tubes is dealt with. One pair of pegs is left empty in the front of the rack when tests are begun, so that as each row of tests is completed, the next may be brought forward. With a rack of the kind described, measuring 17 in. in each direction, there is room for 22 tube sticks, each carrying 40 tubes, so that a single shelf in an incubator measuring 18 in. square, will accommodate 880 tubes.

When the results have been read off, the contents of the tubes attached to each stick are emptied out, and the tubes rinsed repeatedly under the tap. For cleaning out the tubes prior to the final rinsing, a swab connected by a flexible drive to the shaft of a small motor is used. The motor is screwed to a board on the under side of which are two iron brackets for holding it on to the side of the sink. These brackets are readily obtained, as they are used for domestic draining boards (Fig. 4).

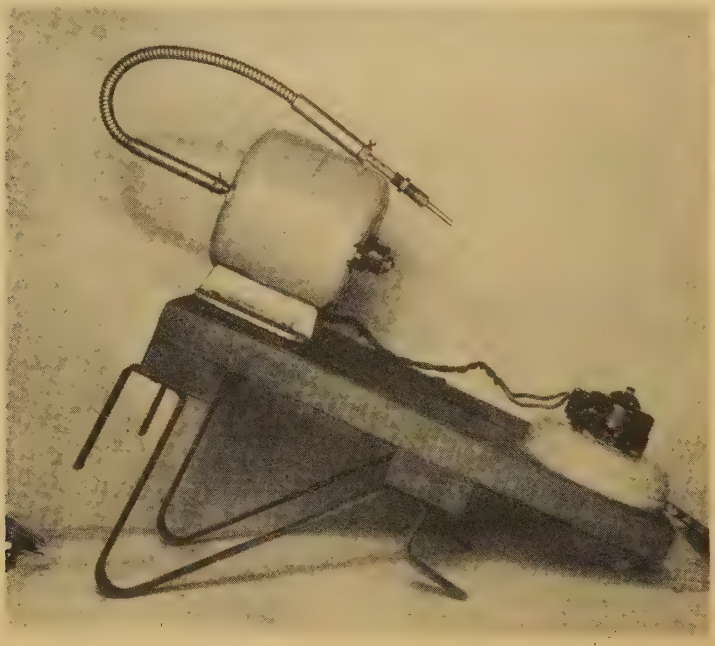


Fig. 4.

No. 3.—Martin's Centrifuge.

Probably everyone using a centrifuge of the Martin type has had the experience at some time or another of having the buckets stick in their recesses on the under side of the revolving head, with consequent loss of contents of the tubes. This difficulty can be overcome by shaping pieces of clock mainspring as shown in the figure (Fig. 5).

Fig. 5.

The pieces of spring are a little shorter than the recesses, and they are clipped on to the plate so that they lie in the recesses with the convex surface downwards. When the machine is running, the convexity is flattened out by the pressure of the buckets, and as the machine slows down the springs regain their shape and the buckets are eased out of the recesses.

SIR JOHN M'FADYEAN'S CONTRIBUTIONS.

1888. Volume 1. Pathology of Hæmoglobinuria in Horses, 1-16. Actinomycosis and Tuberculosis in the Horse, 49-53. Symptoms and Lesions of Swine Fever, 101-113. Lung disease in Sheep caused by *Strongylus rufescens* (with J. R. Dykes), 139-146. A Spontaneous Case of Tuberculosis in the Cat, 156-158. Tuberculosis in the Horse, 335-339.

Editorials.* The Nature of Immunity and Protection in the Case of Infectious Diseases, 40-42. The Suppression of Pleuro-pneumonia, 42-44. The Differentiation of Epizootic Affections of the Pig, 45-46. Can Apparently Healthy Stallions communicate Influenza to Mares ? 46-47. Bovine Tuberculosis, 146-148. Veterinary Surgeons and the Cruelty to Animals Act, 148-151. The Dishorning of Cattle, 151-152. The Report of the Departmental Committee on Pleuro-pneumonia and Tuberculosis, 234-237. The Surgical Treatment of Roaring, 237-239. The Animal Origin of Diphtheria, 239-241. The Study of Comparative Pathology, 348-349. The Difficulty of Diagnosis in Diseases of the Lower Animals, 349-352. The Connection between Human and Animal Tuberculosis, 352-355. The Contagious Character of Strangles, 355-356. A Plea for Literary Honesty, 356.

1889. Volume 2. Actinomycosis, 1-21. A very old Horse, 45-48. Influenza in the Horse— what is it ? 105-115. Tubercular Mastitis in the Cow, 119-126. Notes on Interesting Cases : (1) A Spontaneous Case of Tuberculosis in the Cat ; (2) Primary Sarcoma of the Kidney ; (3) A Case of Mycotic Funiculitis (Scirrhous Cord), 253-258. Amyloid Disease in the Lower Animals, 318-323. Miscellaneous Cases : (1) Echinococcus Cysts in the Horse ; (2) A Case of Acute Endocarditis in a Bullock ; (3) Extensive Tubercular Disease of the Wall of the Heart of a Cow ; (4) Tuberculosis of the Horse ; (5) Two Cases of Discomyces Equi, 347-352.

Editorials. Milk and Scarlatina, 35-37. Epizootic Abortion in Cows, 37-40. Hæmoglobinuria equi, 40-42. Equine Tuberculosis, 42. The Tuberculous Meat Cases at Glasgow, 138-139. Experiments in Queensland regarding Preventive Inoculation in Bovine Pleuro-pneumonia, 139-141. The Inspection of Meat, 141-145. A Bovine Source for the Contagion of Human Typhoid, 245-247. What is meant by General Tuberculosis ? 247-250. The Equine Origin of Tetanus, 250-252. Conflicting Professional Evidence regarding the Carcase of a Cow, 335-338. The Diagnosis of Anthrax, 338-341. The Surgical Treatment of Roaring, 341-342. The Abolition of Private Slaughter Houses, 342-343.

1890. Volume 3. The Occurrence of Tumours in the Domesticated Animals, 35-45, 147-156, 238-249, 337-346. Two Cases of Experimental Tuberculosis in the Equidæ, 70-74. An Improved Steam Steriliser, 156-159. Large Cervical Cyst in a Pig, 270-271.

Editorials. Vomition and Rupture of the Stomach in the Horse, 45-47. How to Stain the Bacilli of Tuberculosis, 48-51. A Practitioner's Microtone, 51-54. Culture of the Bacillus as a Means of Diagnosing Tuberculosis, 54-57. Inspection of Meat at Liverpool, 159-161. The Operative Treatment of Roaring, 162-164. Diphtheria in Domestic Animals, 164-166. International Veterinary Sanitation, 250-253. Protective Inoculation against Black Quarter, 253-256. Equine Tuberculosis : Lymphadenoma, 256-257. The Qualifications necessary for the Office of Meat Inspector, 257-258. (A further Communication on a Remedy for Tuberculosis, by Koch, 301-308.) Protective Inoculation against Black quarter, 346-349. How Pleuro-pneumonia is spread, 349-351. Koch's Remedy for Tuberculosis, 352-353. Milk and Sore Throat, 353-354. Smith's Operation for Sidebone, 354-355.

* Reference is made, within brackets, to a few other publications in successive volumes that are noteworthy for their historic interest.

1891. Volume 4. Experiments with Tuberculinum in Cattle, (helped by Mettam and Stockman), 29-35. Disseminated Necrosis of the Liver, 46-53. A Case of Congenital Tuberculosis, 149-150. The Occurrence of Tumours in the Domesticated Animals, 143-148, 243-247. Some rare Lesions of the Liver and Kidneys, 238-243. Swine Erysipelas, 316-323. Pleuro-pneumonia, 333-344.

Editorials. Protective Inoculation for Black Quarter, 53-55. Koch's Remedy for Tuberculosis, 55-57. Does Milk-fever render the Flesh Unwholesome? 57-59. The Etiology of Tetanus, 150-154. The Discovery of Pleuro-pneumonia in American Cattle, 154-157. The Diagnostic Value of Tuberculin on Cattle, 157-158. The Cause of Equine Influenza, 249-253. The Appointment of Competent Inspectors of Meat, 253-255. Asepsis in Veterinary Surgery, 255-349. Protective Inoculations against Black-leg, 344-349. (Black-leg Experiments—a Report of the Special Committee of the Midland Veterinary Association, 379.)

1892. Volume 5. The Virulence of the Blood and Muscles in Tuberculosis, 22-30. The Staining of Tubercle Bacilli in Milk, 125-127. [Editor here transfers from Edinburgh to London.] Tuberculosis in the Horse, 246-251, 342-348. Mallein as an Aid to the Diagnosis of Glanders (with W. Hunting). (Hobday, Hunting and Calestremé, assistants), 316-338.

Editorials. The Prevalence of Tuberculosis among Cattle in Great Britain, 56-58. An Anthrax Carcase sold for Human Food, 58-60. Tuberculosis in the Sheep and Goat, 61-62. The Prevention of Joint-ill, 62-63. Swine Erysipelas, 63-64. The Curability of Canker of the Horse's Foot, 64-65. Swine Erysipelas, 145-147. The Operative Treatment of Roaring, 147-149. The Struggle against Pleuro-pneumonia, 149-153. The Ventilation of Byres, 153-154. Equine Tuberculosis, 154-155. The Curability of Tetanus, 252-254. Is Tuberculosis a Disease of Domestication? 254-255. The Teaching of Pathology to Veterinary Students, 256. Healing by First Intention after Castration, 257. The Treatment of Actinomycosis, 348-349. The Recent Invasion of Foot-and-Mouth Disease, 350-351. The Diagnosis of Glanders, 351-353.

1893. Volume 6. Mallein as an Aid to the Diagnosis of Glanders, 36-57. (Assistants: Hobday, Falshaw, Edwards, and Calastremé.) The Diagnosis of Tuberculosis in Cattle, 120-144. A Case of Tympanites of the Guttural Pouch, 173-176. Hæmoglobinuria of the Horse, 245-253. Further Observations regarding Tuberculin, 314-320. Epizootic Pneumo-pericarditis in the Turkey, 334-345.

Editorials. Cow Scarlatina again, 57-64. The Treatment of Actinomycosis, 163-164. Mischievous Pathological Terms, 164-165. Pleuro-pneumonia, 165-166. The Etiology of Diarrhoea in Young Calves, 166-168. Anthrax, 253-258. Annual Report of the Army Veterinary Department, 258-260. A New (?) Disease of Cattle, 260-261. Some Points in Connection with the Etiology of Tuberculosis, 261-263. The Treatment of Scirrhous Cord, 263-264. The Jewish Method of Slaughtering Cattle, 346-349. Anthrax, 349-352. The Prevention of Tuberculosis in Cattle, 353-355. Photography in Case Recording, 355-356.

1894. Volume 7. Verminous Pneumonia in Sheep, 31-42. Some Observations regarding the Coccidium Oviforme. Intestinal Psorospermosis in the Pheasant, 131-137. Louping-ill in Sheep, 207-219. Vaccination against Anthrax, 325-332.

Editorials. Pasteurian Vaccination, 52-57. The Serum Therapeutics, 57-59. Immunity, 160-165. Fern Poisoning, 165-167. An Unrecognised Advantage of Public Slaughterhouses, 167-168. The Diagnostic Value of the Local Reaction after Mallein, 263-267. Disappearance of the Bacilli from the Blood in Animals Dead of Anthrax, 267-269. Tuberculosis in Young Cattle, 269-270. Vaccination against Anthrax, 365-368. Inspection of Dairy Cows, 368-369.

1895. Volume 8. The Pulmonary Lesions of Glanders, 50-60. The Etiology of Swine Fever, 306-326. [Concluded that the bacillus isolated from cases was the cause of the disease.] Anthrax among London Horses, 326-330.

Editorials. The Stamping out of Glanders, 74-77. Croupous Pneumonia of the Horse, 77-78. The Report of the Royal Commission on Tuberculosis, 141-145. Ought Tuberculosis to be Included in the Contagious Diseases (Animals) Act? 145-148. The Danger of Tuberculous Meat, 237-239. How are we to Deal with Bovine Tuberculosis? 239-242. International Veterinary Sanitation, 242-245. Anthrax among London Horses, 326-330. Veterinary Surgeons and Meat Inspection, 330-332. African Horse Sickness, 333-334. The Diagnosis of Rabies, 335-336.

1896. Volume 9. Intestinal Psorospermosis in Lambs, 31-35. Contribution to the Morbid Anatomy of Swine Fever, 119-139. Equine Tuberculosis, 190-199. Tuberculosis of Cattle from the Farmer's Point of View, 277-286. Verminous Gastro-enteritis in Cattle, 314-320. Preliminary Note on the Sero-Diagnosis of Glanders, 322-323.

Editorials. The Stamping out of Glanders, 35-39. The Diagnosis of Swine Fever, 146-150. The Diagnostic Value of Swelling of the Throat in Anthrax, 150-152. The Animal Diseases Bill, 152-153. Pleuro-pneumonia, 215-220. Pneumonia in Swine Fever, 220-222. The Butcher as Meat Inspector, 222-223. The Dangers of Tuberculin, 223. Cattle Disease in Jamaica, 323-327. Cattle Plague in Africa, 327-329.

1897. Volume 10. The Etiology of Pneumonia in the Pig, 1-13, 156-161. Parasitic Gastro-enteritis in Sheep and Lambs, 48-63. Horses poisoned by Spoiled Potatoes, 69-71 [Bang. B. The Etiology of Epizootic Abortion, 125-149].

Editorials. Practising Physicians and Animal Tuberculosis, 63-66. The Etiology of Abortion in Cows, 66-68. Swine Erysipelas, 162-165. Medical Officers as Veterinary Inspectors, 166-168. Heredity and Disease, 248-256. The Cure of Tetanus, 257-258. The Duties of Veterinary Surgeons under the New Public Health (Scotland) Act. The Mode of Infection in Glanders, 339-349. The Discussion on pleuro-pneumonia at the Montreal Meeting of the British Medical Association, 49-350.

1898. Volume 11. Anthrax, 51-68. Sarcoptic Mange in Foxes, 92-93. Quarter-Evil, or Black-Quarter, 145-159. The Situation and Order of Development of the Lesions in Bovine Tuberculosis, 226-250. The Infectivity of the Blood, Muscular Tissue, and Lymphatic Glands in Generalised Tuberculosis of the Ox, 298-305. Note on the Experimental Transmission of Warts in the Dog (with F. Hobday), 341-344.

Editorials. The Stamping-out of Rabies, 72-76. The Recrudescence of Swine-Fever, 77-78. Congenital Tuberculosis, 79-80. The London Road Car Company and Glanders, 80-83. Report of the Royal Commission on Tuberculosis, 159-167. The Microbe of Pleuro-pneumonia, 167-170. Report of the Royal Commission on Tuberculosis, 256-263. The Relationship between Human and Bovine Tuberculosis, 344-350.

1899. Volume 12. Results of the Application of the Tuberculin Test to Her Majesty's Dairy Cows at Windsor, 50-56. The Occurrence of Cancer in the Lower Animals, 137-142. Congenital Tuberculosis in the Calf, 156-162. Difficulties in the Diagnosis of Anthrax, 176-178. The National Veterinary Association and Tuberculosis. A Personal Explanation, 250-252.

Editorials. The Stamping-out of Tuberculosis, 57-60. Is the Tuberculin Test Infallible? 61-63. Veterinary Inspection of Milch Cows, 163-168. The Stamping-out of Glanders, 253-259. The Proceedings of the Seventh International Veterinary Congress, 326-331.

1900. Volume 13. African Horse-Sickness, 1-20. The Curability of Glanders, 55-60. Tuberculosis of the Sheep, 59-60. Sarcoptic Mange in the Ox, 73-74. The Etiology of Louping-ill, 145-154. Metastatic lesions in Discomyces, 337-340. Carcinoma of the Stomach in the Horse, 340-342. Rupture of the Diaphragm in a Horse, 342-343. A Remarkable case of Rupture of the Uterus during Parturition, 343-344. Anthrax among City Horses, 344-345. Metastatic Lesions in Bacillary Necrosis, 346-351.

Editorials. The Treatment of Parasitic Gastro-Enteritis, 61-64. The Death Temperature for Tubercle Bacili in Milk, 64-68. The Frequency of Tuberculosis among British Cattle, 68-71. The Contagious Diseases during 1899, 71-73. Mallein in the Treatment of Glanders, 161-169. The Glasgow Conference on Tuberculosis, 169-172. Veterinary Surgeons and the Public Health (Scotland) Act, 171-172. Tuberculosis and Milk, 240-243. The Requirements of an Efficient Meat Inspection, 244-245. Diphtheria in the Horse, 246-248. Pneumonia Contagiosa among English Cattle. What is it? 245-246. The Diagnosis of Foot-and-Mouth Disease, 352-358. [Reliability of the Tuberculin Test. Report by a Committee of the R.A.S.E., 368-381.]

1901. Volume 14. The Distribution of the Lesions in Generalised Tuberculosis, 1-11. A Further Contribution to the Pathology of Horse-Sickness, 103-118. Experiments regarding the Immunisation of Cattle against Tuberculosis, 136-143. Tubercle Bacilli in Cow's Milk as a Possible Source of Tuberculous Disease in Man, 215-224. Bacteriological Examination of the Lesions in a Series of Horses that had Reacted to Mallein, 265-285. A Remarkable Case of Congenital Dipoma in a Calf, 291-293.

Editorials. The *Post-mortem* Diagnosis of Anthrax, 61-65. Foot-and-Mouth Disease, 65-68. The Tuberculin Test, 68-73. Influenza or Pink Eye, 146-148. London County Council and Glanders, 148-151. Abortion in Mares, 151-153. The Cause of Tuberculosis, and the Fallacies of Reasoning from Analogy, 285-289; 354-361. The A.B.C. of Swine Fever, 361-363. Professor Koch's Past and Present Regarding the Relationship between Human and Bovine Tuberculosis, 363-364. The Histology of Brand Cancer, 364-365. [Annual Report for 1900 to R.A.S.E., 90-100.] [Infection of Cattle with Anthrax by means of Linseed Cake—High Court of Justice Trial, 176-201.] [The Combating of Tuberculosis in the Light of the Experience that has been gained in the successful Combating of other Infectious Diseases. By R. Koch. An Address delivered at the British Congress on Tuberculosis, London, July, 1901, 203-215.]

1902. Volume 15. Further Experiments regarding the Immunisation of Cattle against tuberculosis, 60-71. A Case of Carcinoma of the Bladder of a Horse, 148-149. Generalised Carcinoma in a Horse: Negative Result of an Attempt to Transmit the Disease by Inoculation, 149-154. A Peculiar Case of Intussusception of the Small Intestine of the Horse, 154-155. Multiple Polypi in the Small Intestine of a Cow, 155-156. The Susceptibility of the Ass to Tuberculosis, 156-158. A Case of Tuberculosis in a Sheep, 158-159. Rapid Development of Tuberculosis in Young Pigs, 159-161. Cholesteatoma in the Brain of a Horse, 161-162. A Remarkable Outbreak of Goose Septicaemia, 162-165.

Editorials. The Spontaneous Origin of Swine Fever, 71-76. Recent Researches Regarding the Cause of White Scour in Calves, 165-169. Diphtheria of the Cow, 244-250. Glanders: How to Stamp it Out, 250-255. Protective Inoculation against Anthrax and Quarter-evil, 352-359. [The Transmissibility of Bovine Tuberculosis to Man, by R. Koch, 287-300.]

1903. Volume 16. A Peculiar Staining Reaction of the Blood of Animals Dead of Anthrax, 35-40. Extraneous Sources of Infection in Anthrax, 346-357. A Further Note with Regard to the Staining Reaction with Methylene Blue, 360-361. A Contagious Disease of the Generative Organs of

Sheep, 375-376. A Case of Epizootic Lymphangitis, 376-379. Five Cases of Hodgkin's Disease in the Lower Animals, 379-382.

Editorials. The Board of Agriculture on Avian Tuberculosis, 41-43. Cancer Research, 43-44. The Shorthorn Society's Malediction of Tuberculin, 158-160. The Cause and Prevention of White Scours in Calves, 264-269. What is the Best Method of disposing of the Carcases of Animals Dead of Anthrax, 362-364. [From the Annual Report for 1902 of the Principal of the R.V.C. to the R.A.S.E., 84-96.]

1904. Volume 17. (Incorporated with "*The Veterinarian.*") The Colour-Reaction of Anthrax Blood with Methylene Blue: A Question of Priority of publication, 58-60. Glanders, 295-317 [summary of Harben Lectures, 1904—*J. State (Preventive) Med.* (1905), **13,** 1-18, 65-78, 125-135.] A Peculiar Case of Carcinoma in the Horse, 352-354.

Editorials. The *Post-mortem* Diagnosis of Anthrax, 144-149. The Treatment and Prevention of Sheep Scab, 233-240. Preventive Inoculation against Distemper, 240-243.

1905. Volume 18. The Prophylaxis of Glanders, 23-30.

Editorial. The Impropriety of Passing the Carcases of Animals Slaughtered when Moribund, 73-74. [Report of Dorset, Bolton and McBryde on Etiology of Hog Cholera, very fully reproduced, pp. 172-192.]

1906. Volume 19.

Editorial. Sewage Pollution of Drinking Water as a Cause of Disease in Animals, 33-39

1907. Volume 20. Johne's Disease: A Chronic Bacterial Enteritis of Cattle, 48-60.

1908. Volume 21. The Ultravisible Viruses, 58-68, 168-175, 232-242. The Importance of Heredity in Tuberculosis, 332-336.

1909. Volume 22. Anthrax Bacilli in Milk, 148-149.

Summary. [Royal Commission on Tuberculosis, 3rd interim report, 77-84. Abstract: Observations on the Distribution and Diagnosis of Epizootic Abortion in Great Britain. By J. M'Fadyean and S. Stockman. From Report of the Departmental Committee appointed by the Board of Agriculture to enquire into Epizootic Abortion. Appendix to Part I, 264-283.]

1910. Volume 23. The Susceptibility of the Dog to African Horse Sickness, 27-33. What is the Common Method of Infection in Tuberculosis, 239-250, 289-303. Note Regarding Horse Sickness, 325-328.

Summary. [Report of Departmental Committee on Epizootic Abortion, Sir J. M'Fadyean, Chairman. Appointed, 1905. First Report, 1909; Second Report, 1910, 370-374.] [Note: Some of the numbers now become full of General Articles.]

1911. Volume 24. Cholesteatoma in the Brain of a Horse, 137-141. A New Species of Piroplasm (*P. divergens*) found in the Blood of Cattle (with S. Stockman), 340-354.

Summary. [Permanent Commission of the International Veterinary Congresses. Lydtin, President; M'Fadyean, member, submits note of arrangements for holding next, 1914, Congress in London, 379.] [Royal Commission on Tuberculosis (W. Power, Sims Woodhead, Sidney Martin, J. M'Fadyean and Rupert Boyce), appointed, 1901. First interim report, 1904; second, 1907; third, 1909. Final Report, abstracted.] 172-192.] [Departmental Committee on Swine Fever. Appointed, 1910. First interim report, 1911.] [Courthope (Chairman), Luke White, Amstruther Locke, Blake, C. M. Douglas, Frank Garnett, C. E. Lingrose, Penberthy, S. Stockman, 169-172.]

1912. Volume 25. The Agglutination Test in the Diagnosis of Bovine Contagious Abortion (with S. Stockman) 22-38. Johne's Disease (with A. L. Sheather, and J. T. Edwards) 217-275.

1913. Volume 26. Researches Regarding Epizootic Abortion in Cattle (with A. L. Sheather and F. C. Minett) 142-170. Experiments regarding the Vaccination of Cattle against Tuberculosis by the Intravenous Injection of Tubercle Bacilli of the Human and Animal Types (with A. L. Sheather, J. T. Edwards and F. C. Minett) 327-390.

1914. Volume 27. A Case of Johne's Disease Successfully Treated, 76-78. Tuberculosis (presented at the 10th International Veterinary Congress) 218-234. Experiments Regarding Differrent Methods of Tuberculin-Testing (with A. L. Sheather) 323-388.

1915. Volume 28. The Diagnosis of Tuberculosis in Cattle by Inoculation of Guinea-pigs with Antiformined Fæces (with R. H. Knowles) 107-146. The Treatment of Johne's Disease (with A. L. Sheather and J. T. Edwards) 196-216.

[**Summary** of Report of Departmental Committee on Foot-and-Mouth Disease Stockman, M'Fadyean, Mettam and Wragg. Visit to India, 91-96.]

1916. Volume 29. Johne's Disease. The Experimental Transmission of the Disease to Cattle, Sheep and Goats, with Notes regarding the Occurrence of Natural Cases in Sheep and Goats (with A. L. Sheather) 62-94. Johne's Disease. The Reactions of Animals to "Johnin" (with A. L. Sheather and J. T. Edwards), 134-171, 201-243.

1917. Volume 30. Tuberculous Mastitis in the Cow, its Pathogenesis, and Morbid Anatomy and Histology, 57-77, 139-172. Contagious Abortion in Mares and Joint-ill in Foals: Etiology and Serum Treatment (with J. T. Edwards), 321-366.

1918. Volume 31. The Histology of the Lesions of Johne's Disease, 73-87. Scrapie, 102-131. Tuberculosis in the Horse caused by Bacilli of the Avian Type, 225-256. Sarcosporidia as the Cause of Scrapie, 290-299.

1919. Volume 32. Observations with Regard to the Etiology of Joint-ill in Foals (with J. T. Edwards) 42-71. Botryomycosis, 73-89. Joint-ill in Foals: Etiology and Serum Treatment (with J. T. Edwards), 229-283.

1920. Volume 33. Transformation of the Alveolar Epithelium in Verminous Pneumonia in Sheep, 1-10.

1921. Volume 34. Researches regarding Epizootic Abortion in Cattle, 48-64, 105-126, 191-211.

1922. Volume 35. Note regarding the Methylene Blue Stain for Anthrax Blood, 232-233.

1923. Volume 36. Joint-ill in Foals: Treatment with Vaccine (with A. L. Sheather) 22-32. Review of the Progress of Veterinary Science in Great Britain during the Past Hundred Years, 243-255.

1924. Volume 37. Tuberculosis in the Horse, 44-63. Researches regarding Epizootic Abortion in Cattle, 192-203. Fatty Infiltration of the Liver as a Cause of Death in Pregnant Ewes, 287-293.

1925. Volume 38. Contagious Diseases of Animals, with Special Reference to their Prevention, 56-68. Cholesteatoma in the Brain of the Horse, 295-297.

Editorial. The Medical Research Council and Tuberculin Testing, 99-107.

1926. Volume 39. Nil.

1927. Volume 40. [Retired from Principalship R.V.C., London.] Nil.

Editorial. Anthrax at the Zoological Gardens, 1-4.

1928. Volume 41. The Reliability of the Agglutination Test for the Diagnosis of Contagious Abortion in Cattle, 362-369.

1929. Volume 42. Nephritis in Animals. 58-71, 141-162, 231-241.

1930. Volume 43. The Corpora Amylacea of the Mammary Gland of the Cow, 291-300.

1931. Volume 44. Neoplasms in Animals, 266-294.

1932. Volume 45. Actinomycosis and Actinobacillosis, 93-105.

1933. Volume 46. Vaccination against Bovine Contagious Abortion, 50-55. Equine Melanomatosis, 186-204.

1934. Volume 47. Nil.

Editorial. The Double Intradermal Test for Tuberculosis, 67-73.

1935. Volume 48. Nil.

1936. Volume 49. Nil.

1937. Volume 50. Bovine Brucellosis, 69-100.

SIR JOHN M'FADYEAN'S CHIEF CONTRIBUTIONS IN THE JOURNAL OF THE ROYAL AGRICULTURAL SOCIETY OF ENGLAND

1892-1926. Annual Reports from the Royal Veterinary College. These reports contain summaries of the work done at the laboratory which was established at the Royal Veterinary College in 1890 for research in Comparative Pathology and Bacteriology and was maintained by the aid of an annual grant of £500 from the R.A.S.E. "In the first place, the laboratory is now recognised throughout the kingdom as a place to which recourse may be had by veterinary surgeons and members of the Society in the elucidation of what appear to be obscure or unconscious cases of diseases affecting any of the lower animals; and, secondly, the material which is thus sent to the laboratory is daily utilised with great advantage in the practical teaching of pathology to the rising generation of veterinary surgeons." [Annual Report for 1901: this Journal (1902), **15**, 83.]. The reports also contain valuable surveys upon the more important infectious diseases of animals in the country. Many of the earlier reports are reproduced in this Journal.

1892. The Growth of Veterinary Pathology. **53**, 808-811.

1894. On the Disappearance of the Anthrax Bacillus after Death. **55**, 266-269.

1894. Louping-ill in Sheep. **55**, 547-560.

1894. The Prevention of Tuberculosis in Cattle. **55**, 656-663.

1894. Vaccination against Anthrax. **55**, 800-807.

1897. Parasitic Gastritis in Lambs. **58**, 38-56.

1898. The Report of the Royal Commission on Tuberculosis. **59**, 323-354.

1898. The Microbe of Pleuro-pneumonia. **59**, 388-390.

1898. Quarter-evil. **59**, 654-666.

1901. Relation between Human and Bovine Tuberculosis. **62**, 50-57.

1901. Epizootic or Contagious Abortion. **62**, 96-112.

1910. Tuberculosis as regards Heredity in Causation and Elimination from Infected Herds. **71**, 27-45.

1912. Foot-and-Mouth Disease. **73**, 90-103.

1913. Contagious or Epizootic Abortion in Cows. **74**, 89-103.

1917. Swine Fever. **78**, 34-51.

1925-28. Surveys in "Agricultural Research":—

1925. The Causes of Sterility in Cows; Contagious or Epizootic Abortion; Milk Fever in Cows; Foot-and-Mouth Disease; Vaccination of Cattle against Tuberculosis; Johne's Disease; Liver Rot in Sheep. 136-174.

1926. Parasitic Gastritis in Sheep and Cattle; Foot-and-Mouth Disease; Vaccination of Cattle against Tuberculosis; Black Leg; Johne's Disease; A New Disease of Fowls. 168-194.

1927. Foot-and-Mouth Disease; Vaccination against Tuberculosis; Bovine Tuberculosis in Canada; Lamb Dysentery; Botulism; Grass Disease of Horses; Borna Disease; Epizootic Abortion; Rabies; Fowl Pox. 161-190.

1928. Tuberculosis—Vaccination of Cattle against the Disease, the Causes in the Different Species of Domesticated Animals; Contagious or Epizootic Abortion-Epizootic Abortion and Malta Fever, Diagnosis of the Disease, the Disease in Finland; Garget or Mastitis; Foot-and-Mouth Disease; Johne's Disease; Liver Rot in Sheep; Lamb Dysentery; Contagious Pustular Dermatitis in Sheep. 163-193.

SOME FURTHER EXCERPTS.

Quand on voit le style naturel, on est tout étonné et ravi, car on s'attendait de voir un auteur, et on trouve un homme. Pascal. *Pensées.* 29.

" . . . Ignorance is a harsh word, and it is unpalatable to be told that the veterinary profession does not yet know even the ABC of a disease that has been rampant in this country for half a century. It may confidently be stated that this is not the opinion which the veterinary profession entertained of its own knowledge on the subject of swine fever, but, of course, that does not disprove the charge of ignorance. The densest ignorance is generally accompanied by perfect contentment with the amount of knowledge possessed, and by an inability to conceive that there is anything further to learn. The first step towards improvement in such a case is to bring home to the person concerned the fact that he is ignorant, and harshness of language in the process is even excusable. Moralising in this way, one is led to ask whether Mr. Hanbury [President of the Board of Agriculture] in the guise of a candid friend, has not after all done the veterinary profession a good service by pointing out to its members that they do not know even the ABC of swine fever .. . .

" We are told that the Board [of Agriculture] is now engaged in carrying out a more thorough investigation concerning swine fever than has ever been made before, and it has also on hand an *exhaustive* investigation of glanders, and an enquiry into louping-ill and braxy which was launched with a promise that the cause of these diseases and a remedy for them would be discovered. These are dangerous terms in which to describe investigations that have scarcely been begun. We earnestly hope that the results of them will not be disappointing, but we cannot help thinking it is a mistake to trumpet that the mountain is in labour."—Editorial Article. The ABC of Swine Fever. This Journal, 1901, **14**, 361-363.

" . . . That a Cabinet Minister responsible for the administration of the laws relating to the contagious diseases of the domesticated animals should gravely assert that swine-fever may be generated by feeding pigs with ' wash and swill,' or suppose that the incidence of the disease is partly dependent on the movements of tourists, is calculated to create a feeling of stupefaction tinged with despair. In the endeavour to recover our mental bearings after the shock we might be pardoned for asking whether we have suddenly been thrust back to the Middle Ages or transferred to the heart of the Celestial Empire. Is this the first lesson in the ABC of swine-fever, and the opening of a new chapter in epidemiology, which, before it is concluded, may teach us that smallpox is caused by intemperance, and cholera by unchastity ? Or is it merely an example of the crude notions about swine-fever which someone has been writing on the ' clean slate ' of Mr. Hanbury's mind since he assumed the Presidency of the Board of Agriculture ?

" We desire to speak with every respect of Mr. Hanbury. We acknowledge the conspicuous gifts that have brought him to his present position, and the earnestness of his endeavours to safeguard the agricultural interests. On the other hand, when he undertakes to enlighten the public on veterinary questions, we decline to attach any greater importance to his opinions than to those of the ordinary uninstructed layman, except, of course, that we recognise the superiority of their influence for evil when they happen to be wrong. . . "

" We have left the most serious aspect of Mr. Hanbury's opinions regarding swine-fever to the last. It is that they are in the most violent conflict with the opinions of those whose special duty it is to advise him in such matters. The present chief veterinary officer of the Board, and his predecessor in that office, have again and again expressed opinions which cannot by any possibility be reconciled with those which Mr. Hanbury holds regarding the cause of swine-fever. In these circumstances, one naturally wonders who does advise the President of the Board regarding veterinary matters ? It would not be reasonable to suppose that Mr. Hanbury's views on the subject of swine-fever are original in the sense that they are his own conclusions, based on close personal attention to all the available evidence. It is vastly more probable that he has too hastily adopted the opinions of some of those lay officers of the Board whose duties are euphemistically described as administrative, but whose activities are too frequently extended to purely veterinary matters, which they are incapable of fully understanding owing to the lack of an adequate professional training." Editorial Article. The Spontaneous Origin of Swine-Fever. This Journal (1902), **15**, 71-76.

" . . . We say that these discrepancies are calculated to strike one with astonishment. It would be vain to attempt to explain them. A simple explanation would be that Dr. Fleming, not knowing that the official records of the operations were to be submitted to inspection, deliberately falsified the results, but everyone will agree with us that that supposition is almost incredible, and certainly not to be entertained so long as any other explanation is possible. It is quite as difficult to believe that Dr. Fleming's subordinates were guilty of either ignorance or untruthfulness in filling in the record regarding the horses operated upon, or that Dr. Fleming, under oath, asserted that such and such were the results of these operations, without having taken the trouble to ascertain the condition of the horses at the moment when they were sold or destroyed. Meanwhile, the veterinary profession will await Dr. Fleming's explanation, for explain he must, unless he wishes the worst possible construction to be put upon the matter. Editorial Article. The Operative Treatment of Roaring. This Journal, 1890, **3**, 162.

" To Professor Williams I will only say that, while I have on many occasions during the last 20 years had to point out that he was wrong in what he supposed to be facts relating to matters of veterinary pathology, I have never so far forgotten the rules of polite discussion as to charge him with conscious misrepresentation ; and regarding Mr. Fraser's lapse from good manners it need only be remarked that those who put him in the position of honour which he temporarily fills probably expected better things of him. Accusations of *mala fides* against those who do not happen to share our opinions cannot possibly advance our knowledge regarding disputable matters, and they inevitably tend to lower the tone of debate. . . ."—The National Veterinary Association and Tuberculosis. A Personal Explanation. By J. M'Fadyean. This Journal, 1899, **12**, 250-252.

Professor J. M'Fadyean as an Anatomical Writer.

" . . . The book is an honour to the writer, and to his profession. It is a book that teaches anatomy, not as a collection of hard facts, but as a science—as a science that, studied for its own sake, does a young man more good than perhaps any other. . . . It must have cost the author dear in the matter of hard work. The text is entirely new and fresh, and there is not a trace of ' cabinet ' anatomy from the first page to the last. It has been written down upon paper from the very bones themselves. The illustrations are all new, *and fit each other and the text.* It is a pet theory with the writer that what a theatrical manager would call a ' lavish pictorial display ' is thrown away if it does not exactly correspond with the text. There is no confusion here. Everything is shown with pencil that is written of with pen.

" Little or no fault can be found with the nomenclature adopted. Many men have an absurd idea that the author is trying to replace the nomenclature of veterinary anatomy with that of human anatomy. They are quite wrong. There is no settled nomenclature in veterinary anatomy. A horse's muscle is apt to have as many names as the last royal princess. . .

" Besides, to learn special anatomy *easily*, one must study it as much as possible by the methods and in the language of comparative anatomy. The key to a difficult bone is not unfrequently comparison with the very different homologous bone in another animal. And this comparison is impossible if we are to have no language in which to compare. Professor M'Fadyean preserves the good old names of ' flexor perforans,' ' suspensory ligament,' etc. They are terms of special anatomy. But he substitutes ' pisiform ' for ' trapezium,' and so on. And he is right.

" The book, when complete, will no doubt take its place as one of the best works of the Edinburgh School of Anatomists—of the school of Knox, Goodsir, Turner and Richard Owen. It is only a textbook, it is true ; but it is a good one and it contains the results of much original research. It is one more proof that Edinburgh holds the field in Anatomy, though it yields the palm to Cambridge in Physiology. We sometimes think too much of the foreigner. And now and again our folly is brought home to us."—A Review, by W. Limont (Professor of Veterinary Anatomy, Glasgow Veterinary College) of " The Comparative Anatomy of the Domesticated Animals," by J. M'Fadyean, M.B., C.M., B.SC. (W. and A. K. Johnston, Edinburgh and London, 1887.)

[This book, together with Professor M'Fadyean's earlier one on " The Anatomy of the Horse : A Dissection Guide " (1884) have remained the most indispensable books in the training of veterinary students in this country.]

A Noble Aspiration.

" . . . As Sir Michael Foster said at the meeting of the British Association the other day, scientific men may be commonplace and our methods merely founded on common sense, but, gentlemen, science is a glorious temple built by commonplace men and of commonplace materials. Unfortunately, as we build, each in our little corner, we are apt to keep our eyes immediately in front of us, and to think that our own little piece of wall is the most important in the building; we forget the gloriously solid foundations laid down by those who have gone before us, and without which our building could not have reached its present height. Some, again, when they have contemplated their own work, are so engaged in looking down on what has been done that they have no time to contemplate the possibilities of raising a still more beautiful superstructure on what has been already built; they think it is time to put on the roof, because they are convinced that all obtainable knowledge has been crowned in our time or, at any rate, to forget that times may come when our building shall appear a mere foundation of a grander edifice than we can yet conceive. . . ."—Sims Woodhead. Inaugural Address, Royal Veterinary College, London, October 2nd, 1899. (This Journal, 1899, **12**, 362.)

PRINTED IN GREAT BRITAIN BY H. R. GRUBB LTD., CROYDON.